MODERN PLASTICS

SEPTEMBER 1944

R v. 22' Sept. 1944 - Feb. 1945

HIGH FREQUENCY PREHEATING

...in the molding of plastics

■ This message has one idea...to emphasize wartime progress in molding methods which enlarge the field for Durez compounds. In the post-war period, high frequency preheating, along with many other new developments, will provide your custom molder with the means for making his service even more appealing than ever before.

The use of high frequency preheating in the molding of phenolic materials has opened up a completely new field especially in heavy duty materials that is a *natural* for Durez compounds. The principal advantages of this method consist of (1) a reduction in the molding time cycle and (2) a better molded product with greater density, improved electrical properties and a more uniform cure.

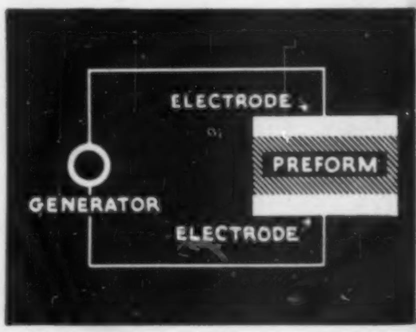
The illustration at left serves as an excellent example of the successful application of high frequency preheating in the production of a molded plastic part. The item pictured is a terminal board for military use which was molded from a preform of high-impact macerated-fabric-type Durez phenolic molding compound.

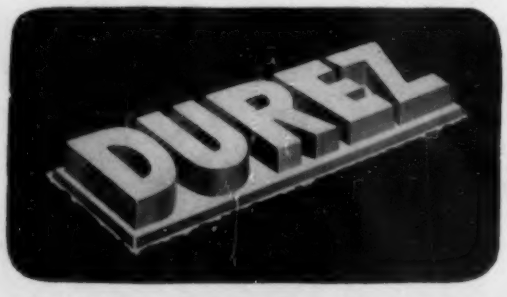
The basic operation of all high frequency preheating is shown in the simple diagram at right (notice the preform in position between the high frequency electrodes). Since the preform is never a perfect non-conductor, some leakage takes place through it. This leakage current manifests itself in the form of heat and thus the preheating of the preform takes place quickly and thoroughly. This method of preheating is particularly valuable when the preforms are of unusually thick, heavy duty material.

The use of high frequency preheating in the molding of plastics is still in the process of development and therefore is extremely limited at the present time. However, the fact that its usage results in a reduction of the molding time cycle and a better product, seems to indicate that it can be viewed as one of tomorrow's certainties.

This is but one of many developments in which Durez phenolics fill the bill. Because of their excellent dielectric properties, inertness to solvents, resistance to impact, high heat, climatic changes, mild acids and alkalies, Durez versatile phenolics have found a place in practically all fields of industry.

Perhaps there is some question in your mind about the inclusion of plastics in your post-war plans. Why not get a competent answer to that question now? Our staff would welcome the opportunity to discuss any plastic material problem with you. Durez Plastics & Chemicals, Inc., 59 Walck Road, North Tonawanda, N. Y.





PHENOLIC MOLDING COMPOUNDS AND RESINS

PLASTICS THAT FIT THE JOB

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CATALIN CORPORATION
announces
"CATAPAK"
A new, low-cost, high-impact compression molding compound!
CATAPAK . . . a superior, new shock-resistant thermosetting molding compound, already in large scale production . . . is the result of a long range laboratory project carried forward by the combined research staffs of the Catalin Corporation and the Marathon Corporation.
This new low-cost material, formulated with lignin, the waste sulphite liquor in the manufacture of paper pulp, offers special advantages to compression molders for immediate and postwar applications.
Inquiries on data, prices and samples are invited!
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Catalin
HIGH STRENGTH
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LOW-COST
CAST PHENOLIC RESINS • LIQUID RESINS • MOLDING COMPOUNDS

MODERN PLASTICS

AND PLASTICS

All editorial contents bearing on military subjects have been released for publication by the Armed Services.

MODERN PLASTICS is regularly indexed in the Industrial Arts Index.

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VOLUME 22 SEPTEMBER 1944 NUMBER 1

General Section

Plastics—Engineering Section

Technical Section

News and Features

"THAT REMINDS ME...

INSUROK HAS LOW MOISTURE ABSORPTION"

The dangers of damage from moisture and corrosion are minimized when INSUROK is used. And, in addition, it has the stamina to absorb shock and to stand up under rough handling.

It is not strange, therefore, that both Molded and Laminated INSUROK are being widely used in war products—are being specified for use in many types of products for tomorrow.

There are many grades and types of Laminated and Molded INSUROK, with a wide range of chemical, electrical and mechanical characteristics. One or more types of INSUROK will meet practically every requirement.

Richardson Plasticians have had years of experience in working with designers and manufacturers. They will be glad to help you determine the grade best suited to your needs. Write for complete engineering information today.

Every day, parts and products made of Laminated or Molded INSUROK are successfully meeting all kinds of moisture and temperature conditions. Be sure to get the facts about this and other characteristics which are causing INSUROK to be specified for so many types of products.

INSUROK *Precision Plastics*

The RICHARDSON COMPANY

MELROSE PARK, ILL. NEW BRUNSWICK, N. J. FOUNDED 1858 INDIANAPOLIS 1, IND. LOCKLAND, CINCINNATI 15, OHIO
DETROIT OFFICE 6-252 G. M. BUILDING, DETROIT 2, MICHIGAN NEW YORK OFFICE, 75 WEST STREET, NEW YORK 6, N. Y.

PROGRESS REPORT ON

POLYTHENE

A NEW PLASTIC BY DU PONT

In polythene, Du Pont introduced to this country a plastic remarkable in its electrical properties, low water absorption, resistance to solvents, impact resistance over a wide range of temperatures, low temperature flexibility without plasticizer and low specific gravity.

Du Pont research has further developed and improved polythene for wire and cable covering. Polythene is being used in the field of insulation for high-frequency cable; and on military communications wire, where the electrical properties of polythene lengthen the talking range, and its light weight is advantageous for carrying long coils of wire.

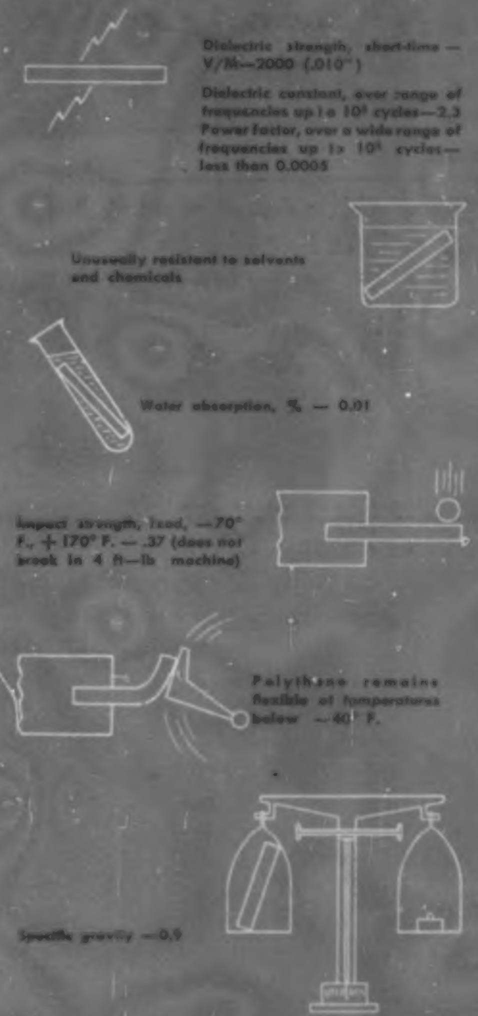
The ease of molding and extrusion of polythene and its excellent physical properties offer broad possibilities in military and postwar applications: in the aircraft industry for wire insulation and other uses, in refrigeration for parts and thermal insulation, in the chemical field for tubing, gaskets and protective coatings, and in packaging for closures and container purposes.

On proper application, polythene can be secured for experimental purposes in five-pound quantities according to WPB Order M-348. Write for polythene properties chart and other data to E. I. Du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, New Jersey.

FOR WHAT'S NEW IN PLASTICS

CONSULT **DU PONT**

Polythene was originated in England by Imperial Chemical Industries, Ltd. In this country, polythene has been developed and improved by Du Pont, which is the exclusive licensee under the basic patents on this plastic (U.S.P. 2153553 and 2188465). At present, Du Pont is producing polythene for important war purposes.



DU PONT

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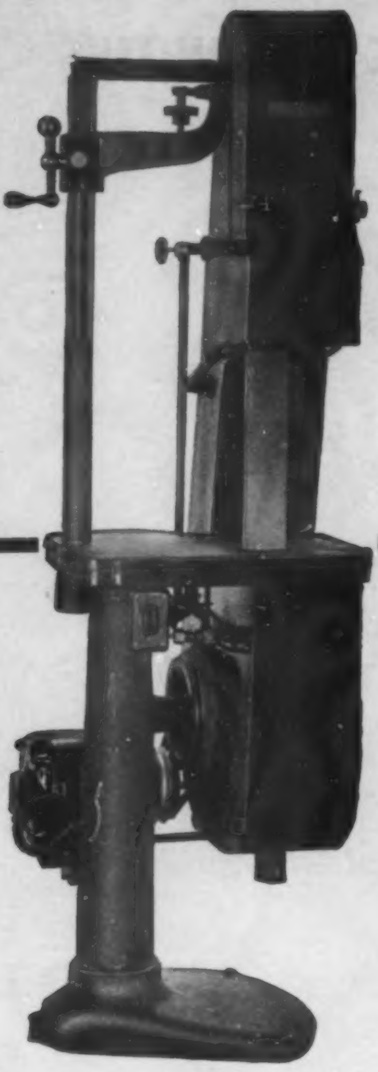
BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY



Porter-Cable's

WET OR DRY

ABRASIVE BELT SURFACING

★ SPEEDS OUTPUT
★ REDUCES SPOILAGE
★ IMPROVES RESULTS

The superiority of Porter-Cable's Abrasive Belt Surfacing, wet or dry, for thermoplastics and some thermo-setting plastics, has been amply demonstrated. When used wet, the coolant is sprayed on the belt before and after cutting, keeping it free and clean. Since there is no heat, the grindings do not "weld" and load the belt. Even materials of low fusion point can be finished without distortion, discoloring, flow.

The B6W Model, especially designed for curved or irregular work, features a flexible belt that follows contours and gets into places inaccessible to other tools. Most jobs can be handled freehand, or with simple fixtures, with a single pass, in a fraction of the time required by other methods—with very substantial savings in time and money—and WITH SUPERIOR FINISH.

Model B-6, with either wet or dry belt

Model G-4, is especially useful in handling small parts, refinishing rejects or oversize parts, or taking off sprues and gates. Machine may be used with belt in horizontal position

Model AG-8 is a high-production machine for close-limit work. Easy to use, it enables green and semi-skilled operators to finish true flats to close limits of flatness and parallelism. Single pieces can be finished free-hand, or mounted in gang jigs for simultaneous finishing of several parts in one pass.

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for a free copy of our latest handbook, "A New Precision Machining Method." It describes new and highly efficient ways of speeding flow of your product from the presses to the packing boxes.

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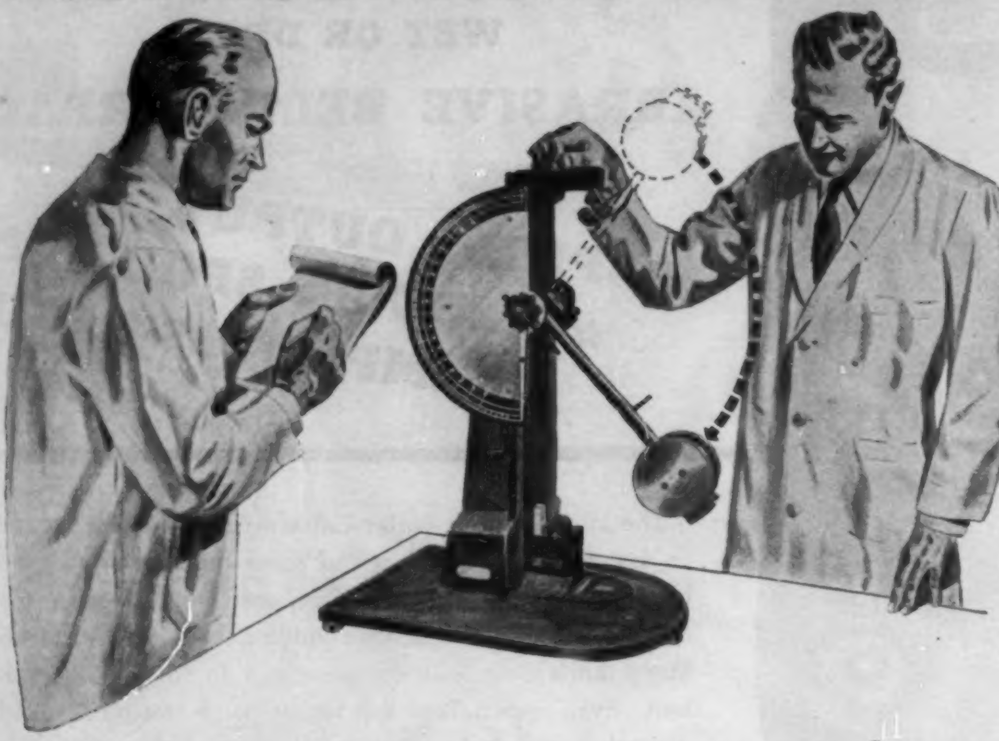
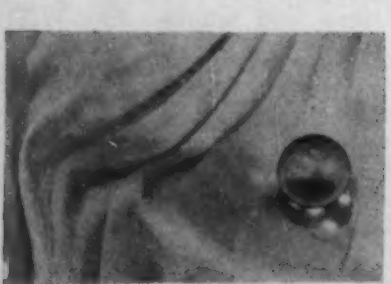
..higher..higher..HIGHER IMPACT STRENGTHS



...open new markets for low-pressure plastic laminates



FIBERGLAS . . . is glass in the form of fine fibers or continuous filaments. These flexible fibers, twisted into yarns and woven into fabrics, produce textile materials in all the forms, weights and dimensions suitable for use as reinforcement in low-pressure plastic laminates. Samples and complete information on Fiberglas Textiles gladly furnished on request. Fiberglas Corporation does not manufacture resins or finished laminates, but shall be pleased to direct you to sources of supply.

For their ingenuity in the rapid development of the new techniques of low-pressure laminating, the plastic manufacturers, designers and fabricators have earned the appreciation of industry. Now, their imaginations are at work on the postwar possibilities of integral, contoured laminated structures.

For many of these uses they're after higher and higher impact strengths in their laminates. And they're reporting important advances in this vital property through the use of Fiberglas* Cloth Reinforcements in combination with appropriate resins.

The individual fibers of Fiberglas have a specific tensile strength beyond that of steel. They have great flexibility and they stand high stresses without permanent deformation. These properties in combination give very high *impact strength* to laminates reinforced with Fiberglas yarns and fabrics. The Fiberglas filaments act as millions of powerful, flexible "muscles" which tend to distribute and absorb impact stresses.

Recently, the U. S. Army Air Corps has permitted publication of some of the results of extensive investigations of Fiberglas-reinforced plastic laminates in aircraft construction. Reprints of published data forwarded on request . . . *Owens-Corning Fiberglas Corp., 1876 Nicholas Bldg., Toledo 1, O. In Canada, Fiberglas Canada, Ltd., Oshawa, Ont.*

FIBERGLAS ...A BASIC MATERIAL

*T. M. Reg. U. S. Pat. Off.

ARMY E NAVY

MILLS PLASTIC

TUBING • PIPE • FITTINGS

MILLS PLASTIC* tubing, pipe and fittings are now used extensively, with outstanding success, to carry the energizing flow essential to war production. Because of their practical adaptability in a wide variety of applications, they will become increasingly popular for industrial, domestic and commercial uses in the peace to come.

MILLS PLASTIC has successfully demonstrated its exceptional qualities under high bursting and working pressures . . . and has also conclusively proved its fine insulating properties, excellent corrosion resistance because it is unaffected by most chemicals, flexibility and ease of handling. In many cases these characteristics make it superior to the vital metals it has replaced.

MILLS PLASTIC tubing is available in outside diameters of 1/8" through 3/4" in a variety of wall thicknesses. Special sizes on request.

MILLS PLASTIC pipe can be obtained in outside diameters of 1/2" through 4".

*Made of Saran

Write on your letterhead for the Injection Molded and Extruded Plastics Catalog III or for the MILLS PLASTIC tubing and fittings circular. *Made of Saran.*

ELMER E. MILLS CORPORATION

Molders of Tenite, Lumarith, Plastacele, Fibestos, Lucite, Crystallite Polystyrene, Styron, Lustron, Loalin, Vinylite, Mills-Plastic, Saran and Other Thermoplastic Materials

153 WEST HURON STREET, CHICAGO 10, ILLINOIS

Our artist can't draw the picture for you. But our engineers can demonstrate the principle to your complete satisfaction. For KYS-ITE is sensationally adaptable. It fits to a "T" innumerable specifications hitherto unreconcilable. No other type of material gives you the unique properties combined in this remarkable plastic. Check the list and see if KYS-ITE isn't the answer to *your* problem, too!

GREAT STRENGTH WITH LIGHT WEIGHT

Preformed before curing, an even impregnation of phenolic resin on interlocking fibres results in great tensile and compressive strength with an impact strength 4 to 5 times that of ordinary plastics.

WIDE RANGE OF SHAPES

Large hollow pieces, complicated pieces with projections and depressions, large or small shapes with thin wall sections — all these and more, too, are molded successfully in KYS-ITE.

KYS-ITE CAN "TAKE IT"

Unusually durable and resistant to abrasion. Impervious to mild alkali and acid solutions.

INTEGRAL COLOR AND FINISH

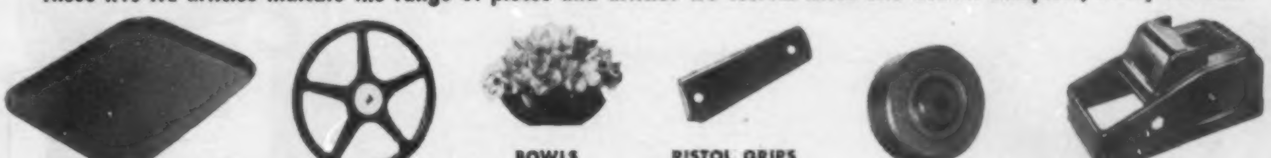
Lustrous finish and beautiful colors are part of the material itself, hence KYS-ITE is permanently attractive. A wipe and it's bright!

NON-CONDUCTOR

KYS-ITE'S dielectric properties make it invaluable where safety is a factor. Also a non-conductor of heat. Non-resonant and non-reverberating.

INVESTIGATE! If your production program calls for any of these features you are cordially invited to bring your problems to the Keyes Service Department. Our engineers will tell you if the article you want can be molded of KYS-ITE. And if it can't be, we'll be glad to suggest the companies which seem most likely to be of help. Let us hear from you.

These KYS-ITE articles indicate the range of pieces and articles we custom mold and deliver complete, ready for use.



TRAYS · VALVE WHEELS · BOWLS · PISTOL GRIPS · ROLLERS · ADDING MACHINE HOUSINGS

KEYES
MOLDED PRODUCTS

Buy War Bonds—and Keep Them

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ERIE RESISTOR CUSTOM MOLDED PLASTICS

Injection Molding of Thermosetting and Thermoplastic Materials
Extrusion Molding

• • •

This Latest Edition of the Erie Plastics Bulletin Contains Information On

- **ENGINEERING AND PRODUCT DESIGN**
- **FINISHED PRODUCTS** —coloring, stamping and other finishing
- **ADAPTABILITY** —replacement for other materials

Send For Your Copy—NOW

ARMY E NAVY
FOR HIGH ACHIEVEMENT IN WAR PRODUCTION

Plastics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND • • TORONTO, CANADA

★ ★ Do More Than Before—Buy EXTRA War Bonds ★ ★

Beauty CAN WAIT!

Because the word "Plastics" is so often associated with beauty and sales-appeal, we want to emphasize the fact that Riegel-X Plastic Laminates are primarily *functional*. Beauty is important but utility comes first today!

This even goes beyond competition with the ordinary functional uses of other plastics and metals, because Riegel-X Plastic Laminates are distinctly new.

They have been tested, approved and put in use throughout the world in order to meet important technical requirements of our war effort — demands for greater light-weight strength, higher thermal insulation, increased dielectric properties, fire resistance, precise fabrication, and other basic qualities that Riegel-X Laminates possess. Many of your products may need these qualities.

For tomorrow's use, progressive manufacturers are already working with these new functional materials for refrigerators, furniture, pre-fabricated homes, boats, pleasure planes and similar important products.

Many other applications are still awaiting development. Find out now where Riegel-X Plastic Laminates fit into your post-war plans. Riegel Paper Corporation, 342 Madison Avenue, New York 17, N. Y.

RIEGEL-X

X **A group of plain and impregnated base papers for both fluid and direct pressure plastic laminates.** X

101

For *small* "see-through" parts, too—

PLEXIGLAS

Gunners on American bombers scan the skies through large PLEXIGLAS nose sections, gun turrets and cockpit canopies, as nearly everyone knows.

But in aviation as well as other fields, this acrylic plastic has countless uses in *small* parts, too, where permanent transparency, light weight, toughness, strength and weather resistance are important factors.

In every case, PLEXIGLAS offers more than mere transparency. It combines clarity with eye appeal and sparkle, with reduced breakage in installation, shipment and service, with excellent electrical and thermal insulating properties.

The advantages of PLEXIGLAS may very well suggest numerous applications of this crystal-clear plastic in your own production plans. For detailed information, direct from the pioneers and principal producers in the field of acrylic plastics, call or write the nearest Rohm & Haas office—Philadelphia, Los Angeles, Detroit, Chicago, Cleveland, New York. Canadian Distributor—Hobbs Glass Ltd., Montreal.

Only ROHM & HAAS makes

PLEXIGLAS

CRYSTAL-CLEAR ACRYLIC SHEETS AND MOLDING POWDERS*

* Formerly CRYSTALITE Molding Powders

ILLUSTRATIONS (*Top to bottom*): Bombardier's panel for the Martin B-26, molded by Plastics Manufacturers, Inc.; motion picture camera window for Republic P-47; fuel gauge molded by Detroit Macoid Corp. These parts are typical of many applications utilizing the transparency, strength, and weather resistance of PLEXIGLAS.

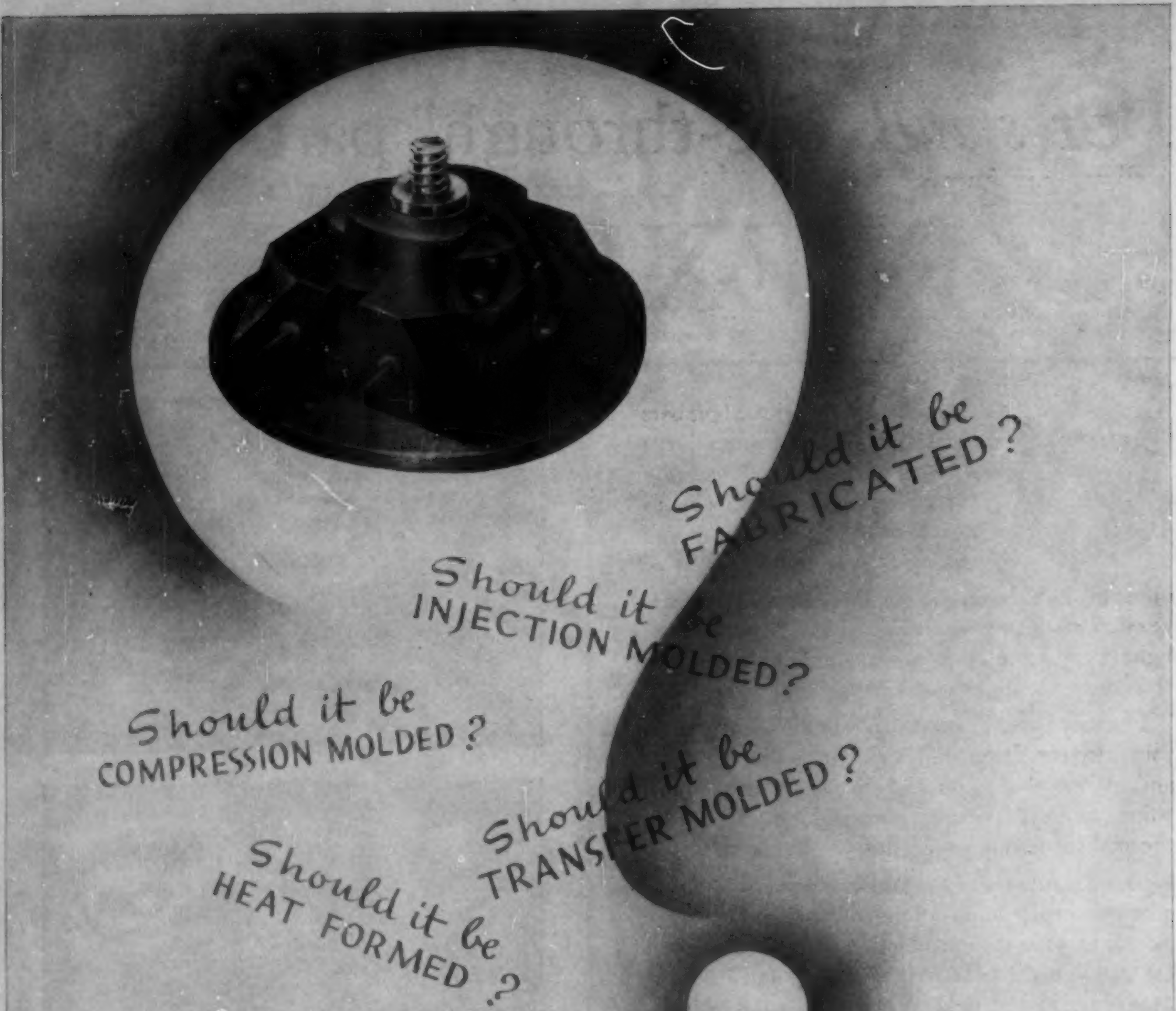
PLEXIGLAS is the trade-mark, Reg. U.S. Pat. Off., for the acrylic resin thermoplastic sheets and molding powders manufactured by Rohm & Haas Company.

Represented by Cia Rohm y Haas, S.R.L., Carlos Pellegrini 331, Buenos Aires, Argentina, and agents in principal South American cities.

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Manufacturers of Chemicals including Plastics . . . Synthetic Insecticides . . . Fungicides . . . Enzymes . . . Chemicals for the Leather, Textile and other Industries



Should it be FABRICATED?
Should it be INJECTION MOLDED?
Should it be COMPRESSION MOLDED?
Should it be TRANSFER MOLDED?
Should it be HEAT FORMED?
THE Right ANSWER IS IMPORTANT TO YOU!
All of the above methods are done in our plant thus assuring the best and most economical production of your plastics requirements.
Send your Tough plastics problems to ~
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435 MIDDLENECK ROAD • GREAT NECK, N.Y. • phone: GREAT NECK 4054

EVERYBODY'S DOING IT!

Or, at least they should be! . . . Doing what? Hard Chrome Plating their dies!

Like the theme of the old popular song hit that swayed us into selecting this title as our caption, plating puts dash and pep into a die — so that no matter how long it *dances* on the press, you can count upon rhythmic performance.

While all this may sound like a frivolous play with words — the net result is still the same melody... Industrial Hard Chromium's plating methods enable dies to glide through their production paces—smoother—better—longer.

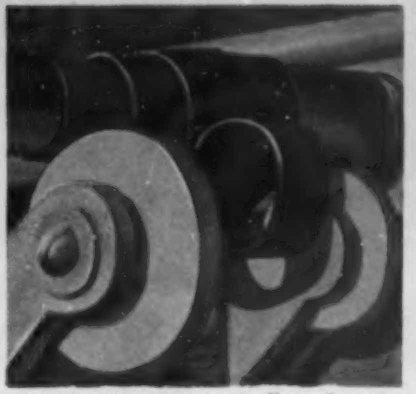
You will be helping to swell the Industrial Hard Chromium chorus of satisfied customers by "Doing It", too! . . . The first step is your inquiry!

INDUSTRIAL HARD CHROMIUM Co.

"Armorplate for Industry"

15 ROME STREET • NEWARK 5, NEW JERSEY

FOR IMPACT STRENGTH, the grip of the jungle fighter's machete is made of tough cellulose acetate plastic, molded by the Cruver Manufacturing Company.



ON THE "THUNDERBOLT," rollers of acetate plastic pass the ammunition to the six wing-guns. Material: *Lumarith*, Celanese Celluloid Corp. Molder· The Pyro Plastics Co.

"FATHER OF ALL PLASTICS," cellulose nitrate was discovered in 1868. Today this plastic is widely used wherever impact-resistance is primary.

CELLULOSE PLASTICS ARE *TOUGH!*

If your product calls for a plastic that can really take a beating—violent shock and impact, constant wear, even at extremes of temperature—remember that among all the characteristics of all the plastics the toughness of the Cellulose plastics is outstanding.

The inherent strength of the Cellulose plastics, caused by the long-chain cellulose molecule, makes cellulose compounds hard to chip or crack or shatter. This is true of hard molded plastics, film and foil, and coatings of cellulose-base lacquers. In Cellulose Acetate, Cellulose Nitrate, or Ethyl Cellulose, you will find the toughness you need for your product, coupled with other advantages which make the Cellulose plastics unique.

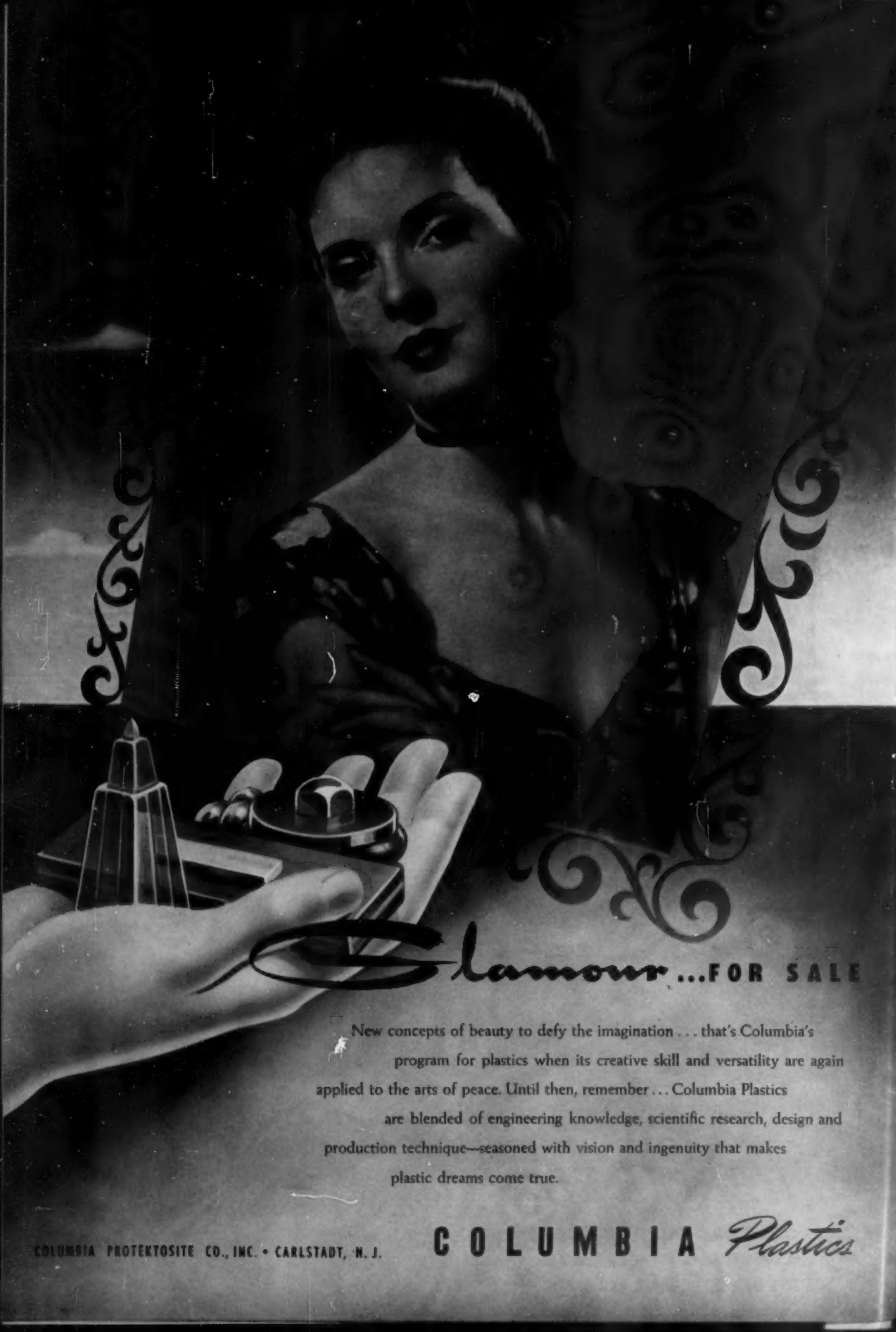
Hercules does not make plastics, but as a leading producer of cellulose derivatives is working constantly to supply those who do make plastics with even better and more versatile base materials. The literature we have for you is based on our years of experience in supplying cellulose materials of exceptional quality. Address your letter to Cellulose Products, Department MP-94, **Hercules Powder Company, Wilmington 99, Delaware**

FLEXIBLE · STABLE · TOUGH · LIGHTWEIGHT · CLEAR · ECONOMICAL

W TO DISARM THE ENEMY!
ause the dummy pistols
d in combat training must
e a terrific beating they
molded of tough
lulose acetate.
lder: Cruver
. Co.)

HERCULES

CELLULOSE ACETATE
CELLULOSE NITRATE
ETHYL CELLULOSE


Glamour...FOR SALE
New concepts of beauty to defy the imagination . . . that's Columbia's program for plastics when its creative skill and versatility are again applied to the arts of peace. Until then, remember . . . Columbia Plastics are blended of engineering knowledge, scientific research, design and production technique—seasoned with vision and ingenuity that makes plastic dreams come true.
COLUMBIA PROTEKTOSITE CO., INC. • CARLSTADT, N. J.
COLUMBIA Plastics

PLASTICS for MODERN SURGERY

*Courtesy National Electric Instrument Company.

The cautery with transformer housing, cautery pistol and tips molded from #4 Special Formula Neillite and the specialist's headlight are only a few of the shapes that Watertown has molded for surgical and diagnostic equipment for National Electric Instrument Company. Plastics have proved their value in medical, surgical and hospital fields because of their clean fine surfaces, adaptability to existent designs and sterling performance.

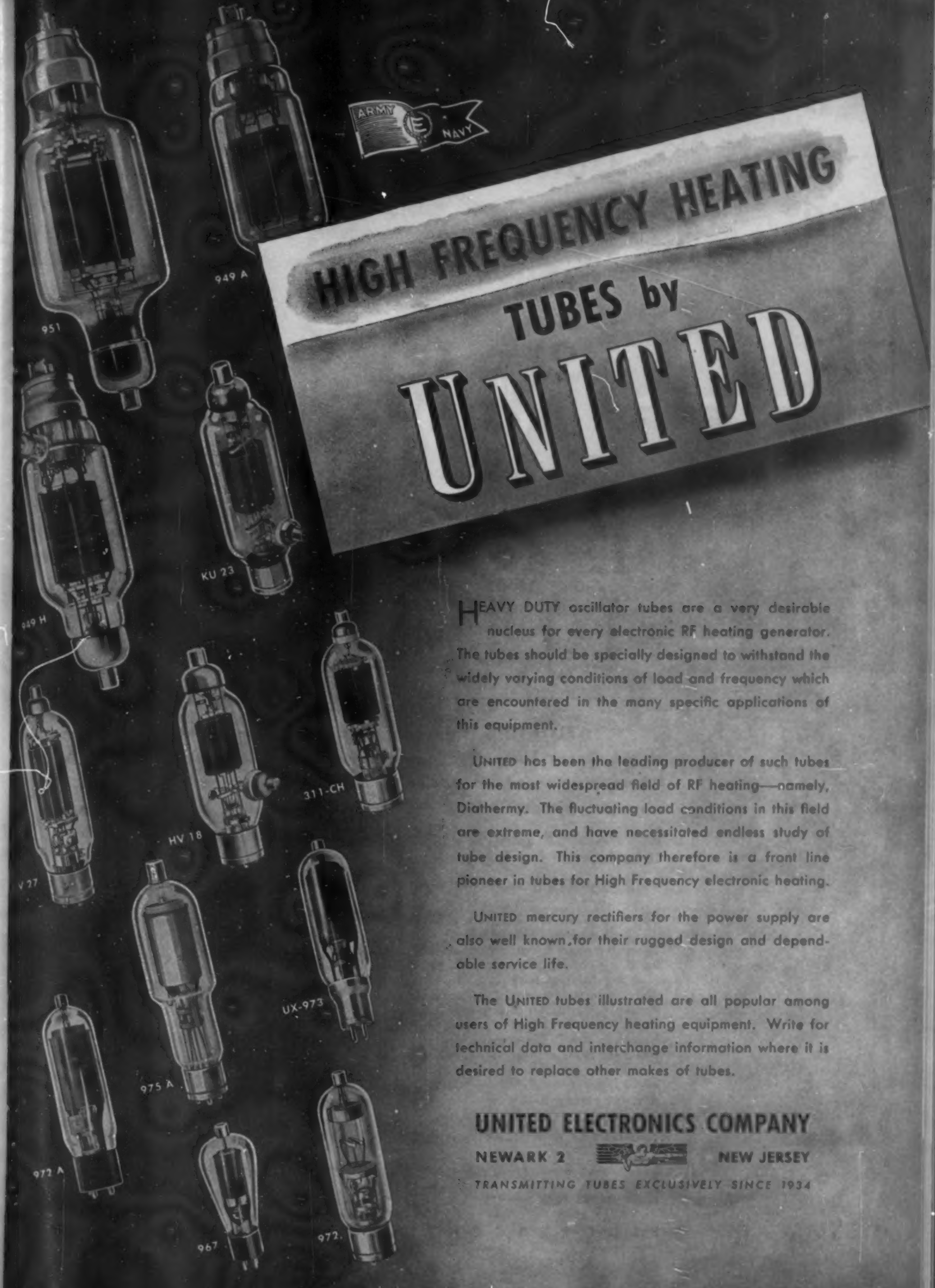
While the cautery uses one material, a Neillite especially developed for National Electric Instrument Company by Watertown engineers, the headlight uses three different plastics, Neillite, ethyl cellulose and cellulose acetate. Many surgical instruments owe their fine precision and trustworthy performance to Watertown's skillful mold making, molding and development of special basic materials to meet rigid specifications devised by the manufacturer.

Consult Watertown engineers for sound advice on your plastics problems.

The Watertown Manufacturing Company, 1000 Echo Lake Road, Watertown, Connecticut. Branch office—Cleveland, Ohio. Sales offices—New York, Chicago, Detroit and Milwaukee.

Watertown

A NAME AS OLD AS THE PLASTICS INDUSTRY


ARMY
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NAVY
HIGH FREQUENCY HEATING
TUBES by
UNITED
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KU 23
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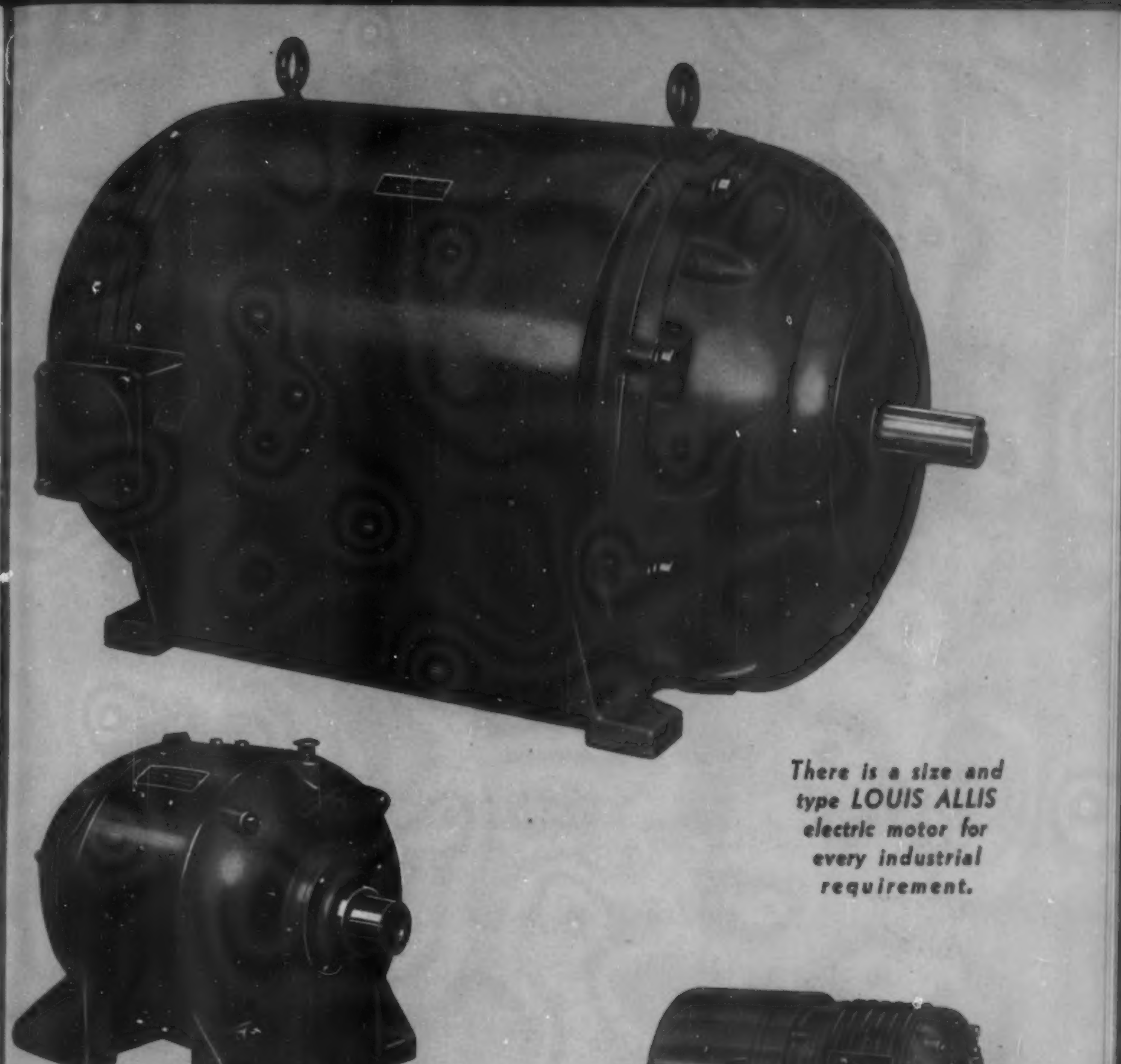
HEAVY DUTY oscillator tubes are a very desirable nucleus for every electronic RF heating generator. The tubes should be specially designed to withstand the widely varying conditions of load and frequency which are encountered in the many specific applications of this equipment.
UNITED has been the leading producer of such tubes for the most widespread field of RF heating—namely, Diathermy. The fluctuating load conditions in this field are extreme, and have necessitated endless study of tube design. This company therefore is a front line pioneer in tubes for High Frequency electronic heating.
UNITED mercury rectifiers for the power supply are also well known for their rugged design and dependable service life.
The UNITED tubes illustrated are all popular among users of High Frequency heating equipment. Write for technical data and interchange information where it is desired to replace other makes of tubes.
UNITED ELECTRONICS COMPANY
NEWARK 2
NEW JERSEY
TRANSMITTING TUBES EXCLUSIVELY SINCE 1934


There is a size and type LOUIS ALLIS electric motor for every industrial requirement.
THE LOUIS ALLIS CO., MILWAUKEE 7, WIS.

PLASTICS *at his fingertips*

OUT

WITH A PULL OF

1450 lbs.

when mechanically anchored

IN

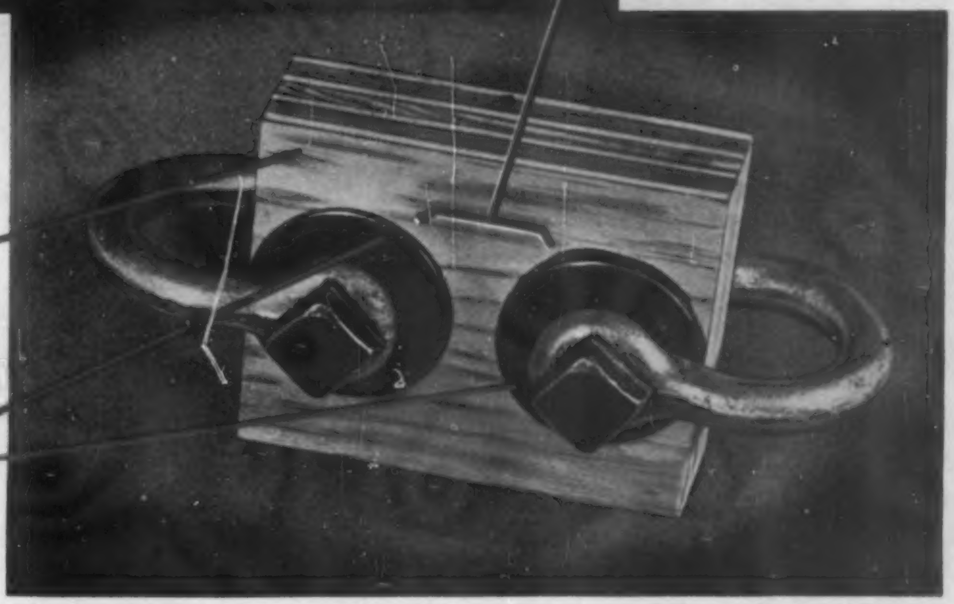
**WITHSTANDING
A PULL OF**

4000 lbs.

when metal rings are

CORDO-BONDED

to the wood



**PLYWOOD
1 3/16" THICK**

CORDO-BONDED

**to
metal
reinforcing rings**

Actual Photographs

CORDO-BOND Adhesives are helping to solve present and post-war bonding problems for a wide variety of product applications and industrial uses.

Perhaps we can be of help with your bonding problems. Please write, giving details for specific analysis—or request Catalogue outlining CORDO-BOND Adhesives, uses, characteristics, bonding processes.

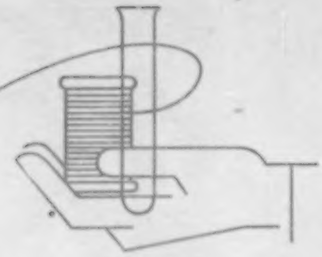
CORDO CHEMICAL CORPORATION
34 Smith St., Norwalk, Conn.

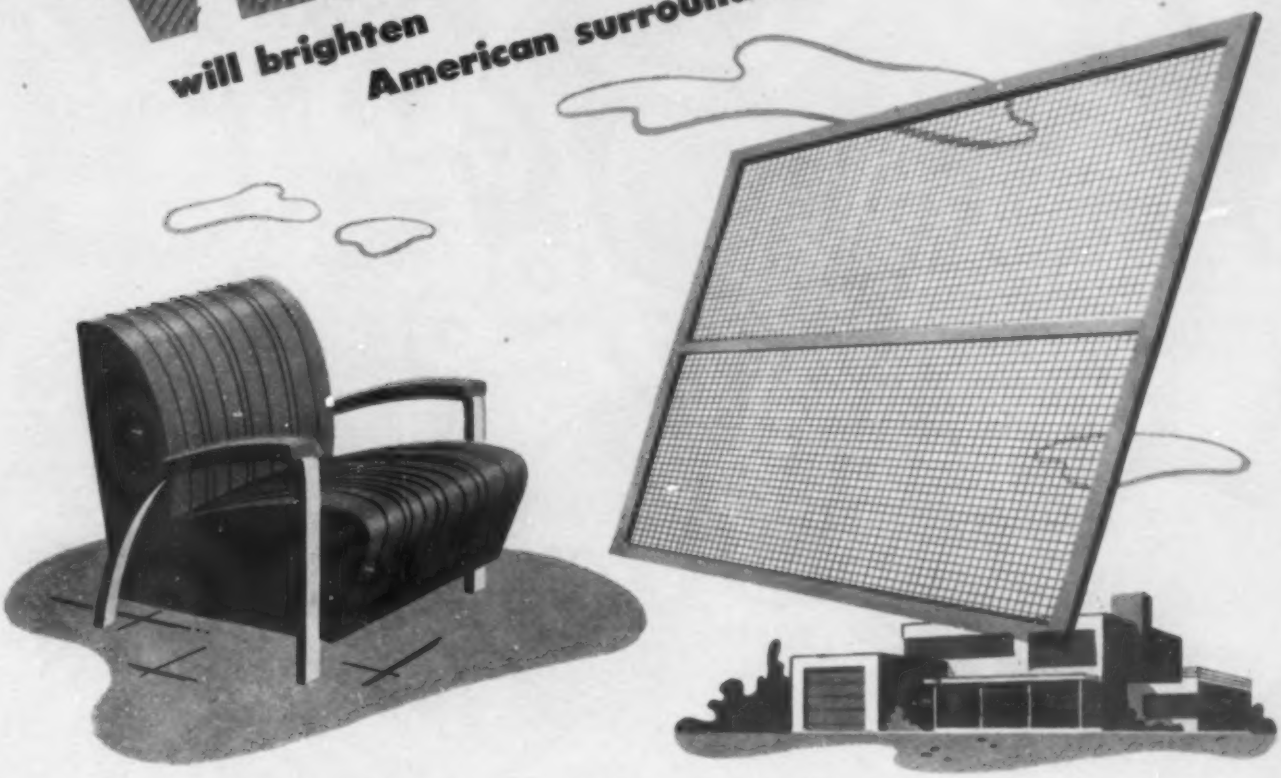
INDUSTRIAL COATINGS • FINISHES
INDUSTRIAL ADHESIVES

CORDO-BOND

COLORFUL VELON*

will brighten American surroundings





– in a million places

– in a thousand ways

If you're thinking of color for your post-war product, write down that word VELON, in capital letters.

If you're thinking of durability beyond all known standards of wear, write it once more; the name is *Velon.*

If you are thinking of beauty that is virtually indestructible, that can *always* be restored to its original freshness with a mere wipe of a damp cloth, write it still again — *Velon,* Firestone's new wonder material.

It will be made to your specifications in the brightest, or deepest and richest tones. In an infinite variety of forms, and in any conceivable pattern. Just let your imagination go; *Velon* will match it to the letter!

With *Velon* there is no such thing as an impractical color. It is stainless, highly resistant to acids, alkalis, nearly 100% non-absorbent, non-inflammable, non-fading.

All *Velon* now made goes to war. But postwar America will be brightened in a million places, a thousand ways. Including *your* product? Make a memo of that name: *Velon!*

For the best in music, listen to the Voice of Firestone, Monday evenings over the entire NBC coast-to-coast network.

ANOTHER CONTRIBUTION TO A BETTER WAY OF LIFE by **Firestone**

*TRADE MARK • Pronounced VEL-LON

How full is "FULL RESPONSIBILITY" in Plastics?

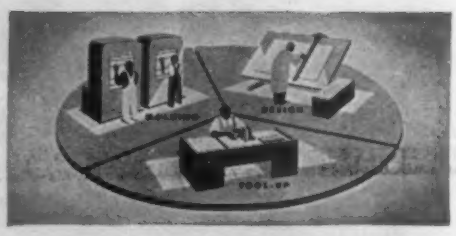
It even includes production of your inserts, here at Kurz-Kasch!

Because delayed deliveries on inserts—or a slip on tolerances—can snarl up the most carefully planned delivery schedule, we've set up a complete shop for insert production in our plant.

This shop is equipped to work zinc, monel metal, berrylium copper, aluminum, stainless steel, brass, chromium, steel and other materials—by stamping, screw machine work, drilling, tapping, reaming or whatever. Special finishing by dipping, plating, or pickling can be furnished.

By producing inserts under the same precision standards that have always applied to mold-making, molding and finishing at Kurz-Kasch, we can literally accept full responsibility for your plastic application from design to delivery.

Lay your postwar plastics problems on the Kurz-Kasch Round Table now for difficult plastics parts precisely produced—on schedule—at a fair price—when you'll need them.



One of the largest, best-equipped exclusive custom molding plants in the country—staffed by veterans of the plastics industry. At the Kurz-Kasch Round Table, experts in every phase of plastics production solve your engineering and production problems *first*—can help now with the applications you'll need soon.

NOW'S THE TIME FOR AN EXTRA WAR BOND—TODAY

KURZ-KASCH

For over 25 years Planners and Molders in Plastics

Kurz-Kasch, Inc., 1421 South Broadway, Dayton 1, Ohio
Branch Sales Offices: New York • Chicago • Detroit • Indianapolis • Los Angeles • Dallas
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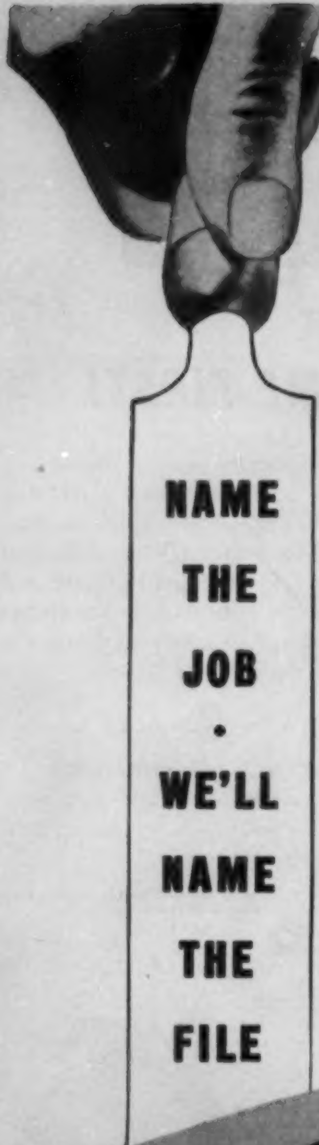


BY FAR the largest number of plastics finishing and fitting jobs involve filing. Because plastics constitute such a wide range of textures, densities and hardnesses, Nicholson has given much time to field and engineering-laboratory tests to determine *The right file for the job.*

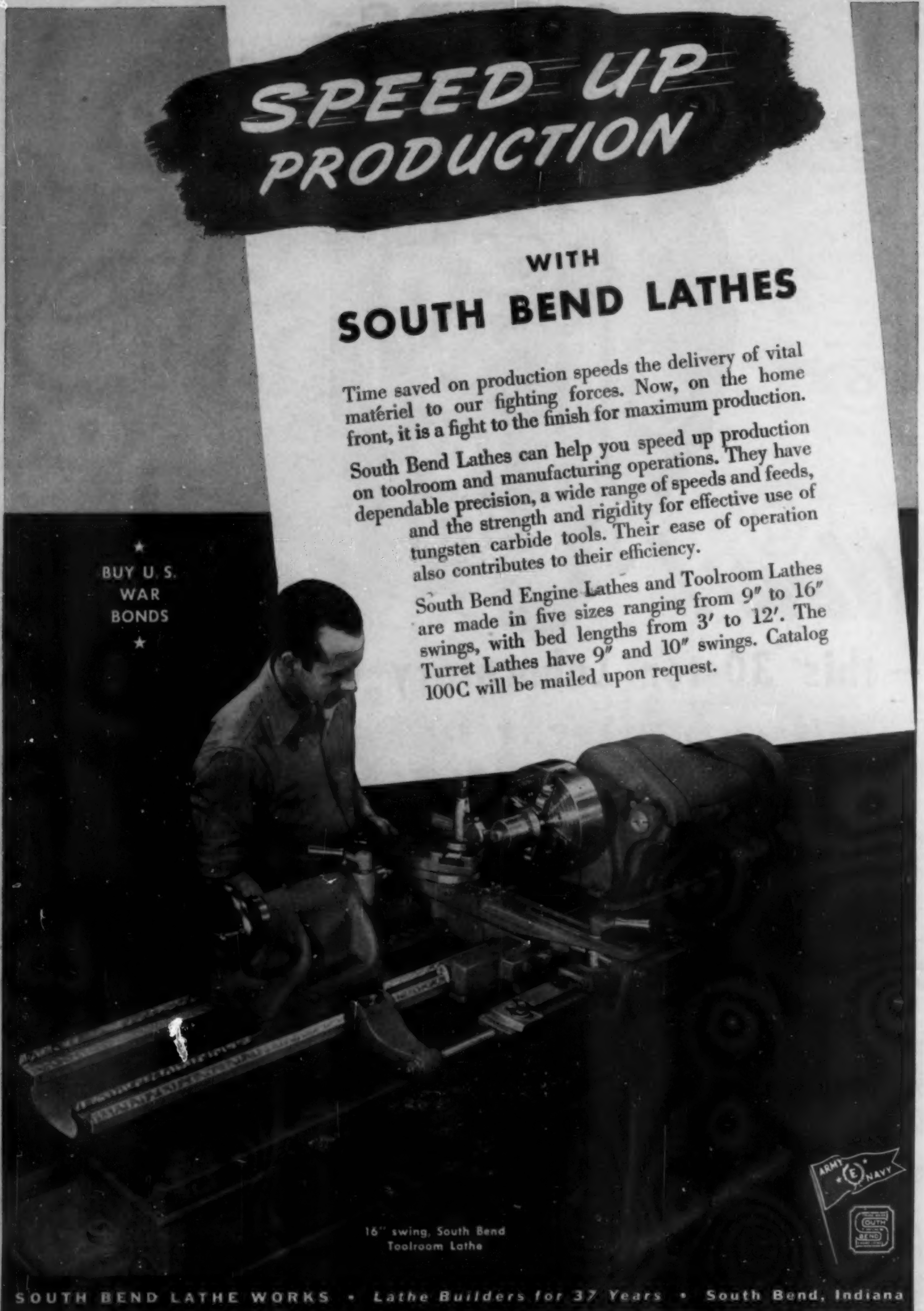
Shapes, cuts and individual file-tooth design are all important. Hard plastics call for files with high, thin-topped teeth — to keep on doing good cutting work as the teeth wear down. For soft, shreddy plastics, file-teeth gullets must be wider than usual — to minimize clogging.

Below is a typical assortment of shapes of Nicholson Files for plastics. These are in Swiss Pattern design, though many Nicholson Regular and several so-called Special Purpose files are practical for plastics work.

Giving us a few details pertaining to your plastics filing problem will enable our engineers to *name the file* — and give your production heads suggestions in its application. Write us freely. And for the purchase of Nicholson or Black Diamond Files, contact your mill-supply house.

FREE — 48-PAGE BOOK, *"FILE FILOSOPHY."* Illustrates and describes scores of files. Tells about file manufacture, file use, file care, file terminology. Invaluable to production and purchasing heads, foremen, tool-shop mechanics.

NICHOLSON FILE CO., 44 ACORN ST., PROVIDENCE 1, R. I., U. S. A.
(Also Canadian Plant, Port Hope, Ont.)


SPEED UP PRODUCTION
WITH
SOUTH BEND LATHES
Time saved on production speeds the delivery of vital matériel to our fighting forces. Now, on the home front, it is a fight to the finish for maximum production.
South Bend Lathes can help you speed up production on toolroom and manufacturing operations. They have dependable precision, a wide range of speeds and feeds, and the strength and rigidity for effective use of tungsten carbide tools. Their ease of operation also contributes to their efficiency.
South Bend Engine Lathes and Toolroom Lathes are made in five sizes ranging from 9″ to 16″ swings, with bed lengths from 3′ to 12′. The Turret Lathes have 9″ and 10″ swings. Catalog 100C will be mailed upon request.
★ BUY U. S. WAR BONDS ★
ARMY E NAVY
16″ swing, South Bend Toolroom Lathe
SOUTH BEND LATHE WORKS • Lathe Builders for 37 Years • South Bend, Indiana

WATERBURY PLASTICS
Moldings of Merit

When Louis Jacques Mande Daguerre of France perfected his photographic process in 1839, he little thought that it would lead to the development of a great American industry. Yet, out of the need to protect the sensitive Daguerreotype from fading, composition cases of remarkable beauty were created and that was the start of Plastic Molding in this country.

In those pioneer days Waterbury Companies, Inc., then known as The Waterbury Button Company, made buttons, mirror frames, checkers and dominoes of plastic material. Later on they molded quantities of phonograph records. Since then, newer plastics have been developed and their use has expanded into hundreds of industries, and countless applications now enter into our daily lives.

Today, Waterbury Companies, Inc., serves American industry with a wide variety of plastic products, as well as with metal parts, lighting fixtures, buttons, toys and metal sundries.

Manufacturers working with this versatile company enjoy the advantages and economies that come from having their metal and plastic parts made in one plant under one responsibility; molded together when required, or assembled in complete units.

Look to this progressive company for your plastic and metal needs: Six complete manufacturing divisions, three laboratories, experienced engineers, designers and technicians are ready to serve you. When writing address Dept. B.

BUY MORE WAR BONDS—HASTEN VICTORY

WATERBURY COMPANIES, INC.
Formerly Waterbury Button Co., Est. 1812
WATERBURY, CONNECTICUT

WHY BURDEN YOUR POST-WAR PRODUCT WITH NEEDLESS TAPPING COSTS!

...USE *The Short-Cut Method!*

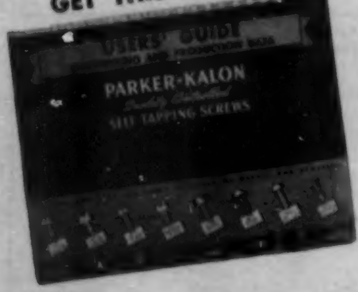
Let the P-K Assembly Engineer show you how to take out tapping and put in PROFITS. The *Short-cut* fastening method, with Parker-Kalon Self-tapping Screws, eliminates the tapping and tap expense of machine screw fastenings. On many jobs, this means savings in assembly time and labor of from 30% to 50%.

You can make similar savings when you use P-K Screws to replace slow bolt-and-nut fastenings, troublesome inserts in plastics, riveting in hard-to-reach places. One operation makes a fastening with a P-K Screw. You just drive it into a plain, untapped hole. Truly a short-cut method! It makes a stronger fastening, too.

Before your post-war assembly practices are set up, talk over your fastening problems with a P-K Assembly Engineer. You'll find his recommendations unbiased. He'll suggest P-K Screws only when they will save time, lower costs, provide stronger fastenings. No matter what kind of plastics, or metal, you are working with, there's a P-K Screw designed for the job, and you'll find you can adopt it to advantage in 7 out of 10 cases.

No special tools or skilled help are required. You can switch to P-K Screws overnight.

GET THIS GUIDE —



TO HELP YOU PLAN POST-WAR ASSEMBLIES, Parker-Kalon has prepared a handy "Users' Guide", giving information you need on all types of P-K Self-tapping Screws. It is arranged so you can find facts quickly, and made file size, with a hanger for use as a wall chart. Write for your copy. Parker-Kalon Corp., 208 Varick St., New York 14, N. Y.

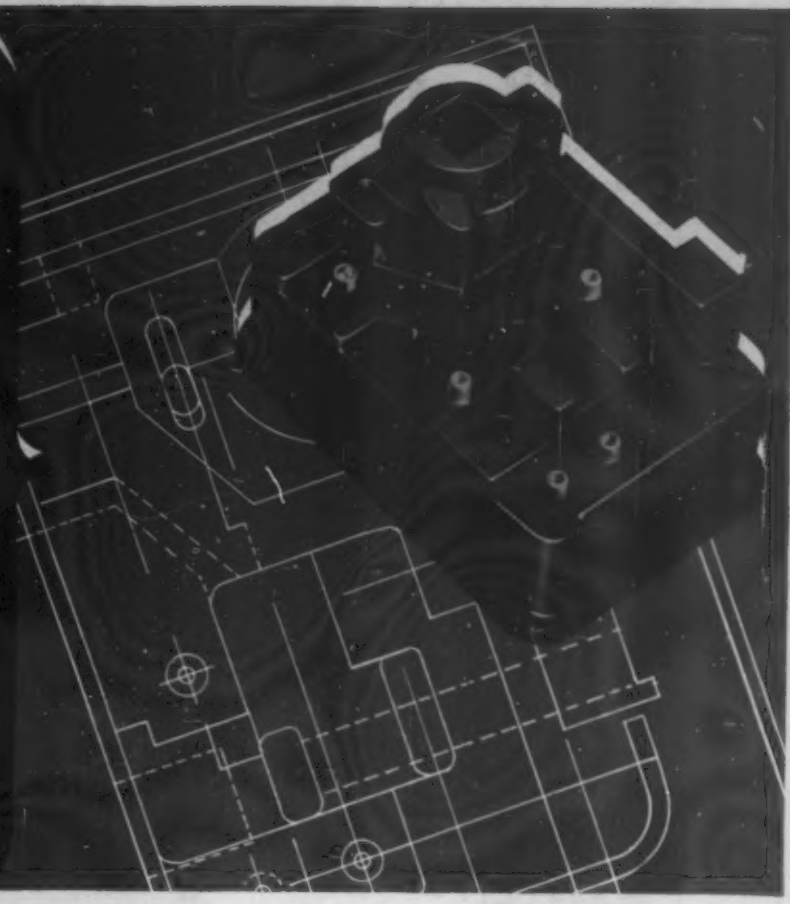
PARKER-KALON

Quality-Controlled

SELF-TAPPING SCREWS

SELF-TAPPING SCREWS FOR EVERY METAL AND PLASTIC ASSEMBLY

WE READ BETWEEN THE BLUEPRINT LINES



PLASTIC MOLDERS can look at a prospective job from two angles. They can take the blueprint you supply, figure their methods, materials, costs and deliveries exactly as indicated. That is, they can read just the lines on the blueprints.

AT GENERAL INDUSTRIES, we do more. Naturally, you know the functions of the plastic part better than we do, so we don't attempt any major design changes. *But we do know plastics,* and from our wide experience can make suggestions which come from reading between the lines of the blueprint.

QUITE OFTEN, our customers have found that our ideas result in a product improved in utility or appearance, delivered quicker and at a lower final cost.

THIS METHOD calls for wide experience in the plastic industry. It requires a real knowledge of mold making and of the characteristics of the many different plastic compounds. And, of course, it must be backed up by modern equipment and operators who know their jobs.

SO, when you are thinking of postwar plastic parts, we suggest that you ask us to "read between the blueprint lines." Right now, we're 100% on war work, but when that job is done, we'll have engineers and facilities to take on your peacetime plastic molding. We'd like to have you call on us.

ARMY E NAVY

THE GENERAL INDUSTRIES COMPANY

MOLDED PLASTICS

Molded Plastics Division • Elyria, Ohio

Chicago: Phone Central 8431 | Milwaukee: Phone Daly 6818
Detroit: Phone Madison 2146 | Philadelphia: Phone Camden 2215

Daniel Szantay

Mr. Szantay and three associates, founded The Sinko Tool & Mfg. Co. 25 years ago. With his guidance, the business has grown and prospered. An expert tool designer, he was also a pioneer in molding thermoplastics. Today as the owner of the company, Mr. Szantay continues to supervise the management of the business.

Announcing—

the change ***in name*** of one of America's leading manufacturers of Injection Molded Plastic parts and products. The Sinko Tool & Manufacturing Company will hereafter be known as SANTAY CORPORATION. For many months, 100% of our facilities have been operating three shifts a day, producing intricate Thermoplastic Parts and Electro-Mechanical Assemblies for the Army and Navy. Invaluable knowledge and experience has been gained, which is bound to be reflected in the products we make in the future. Post-war planners are invited to consult with our master craftsmen on the simplest or most involved metal or thermoplastic part or product.

SANTAY CORPORATION

FORMERLY SINKO TOOL & MANUFACTURING CO.

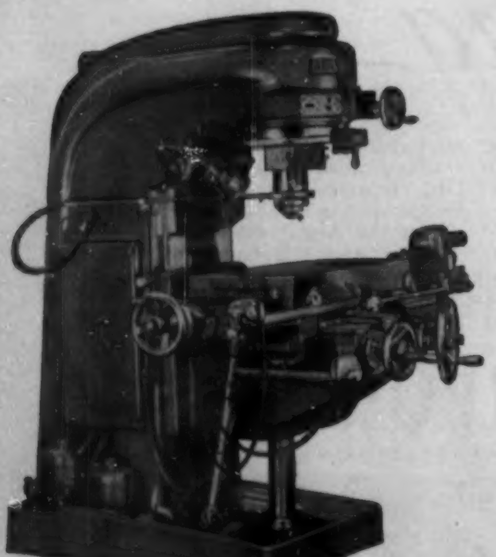
351-359 NORTH CRAWFORD AVENUE • CHICAGO 24, ILLINOIS

INJECTION MOLDING AND METAL STAMPING • ELECTRO-MECHANICAL ASSEMBLIES

ROTARY HEAD MILLER . . . PLUS CHERRYING ATTACHMENT . . . SIMPLIFIES THIS "*TRICKY*" MILLING OPERATION

The Milwaukee Rotary Head Miller equipped with a cherrying attachment made "short work" of the "*tricky*" milling required on this injection mold. It took just two hours to complete the job — far less time than by any other method known.

The cherrying attachment is an auxiliary rotary head, mounted at 90° to the head of the miller. It is used to mill circles and angles in a vertical plane. When used with rotary head motion, spherical and conical cavities can be accurately and rapidly milled — in almost all cases difficult operations become a comparatively simple task.



KEARNEY & TRECKER'S ROTARY HEAD MILLER

The Most Versatile Machine Ever Designed for Mold and Die Work

DIRECT . . . mills mold cavities in a single set-up without the aid of templets or models.

ACCURATE . . . chances for error are eliminated because there is no change in set-up. Exact control of all combinations of cutting movements —possible only with this machine— transmits mathematical precision to the work.

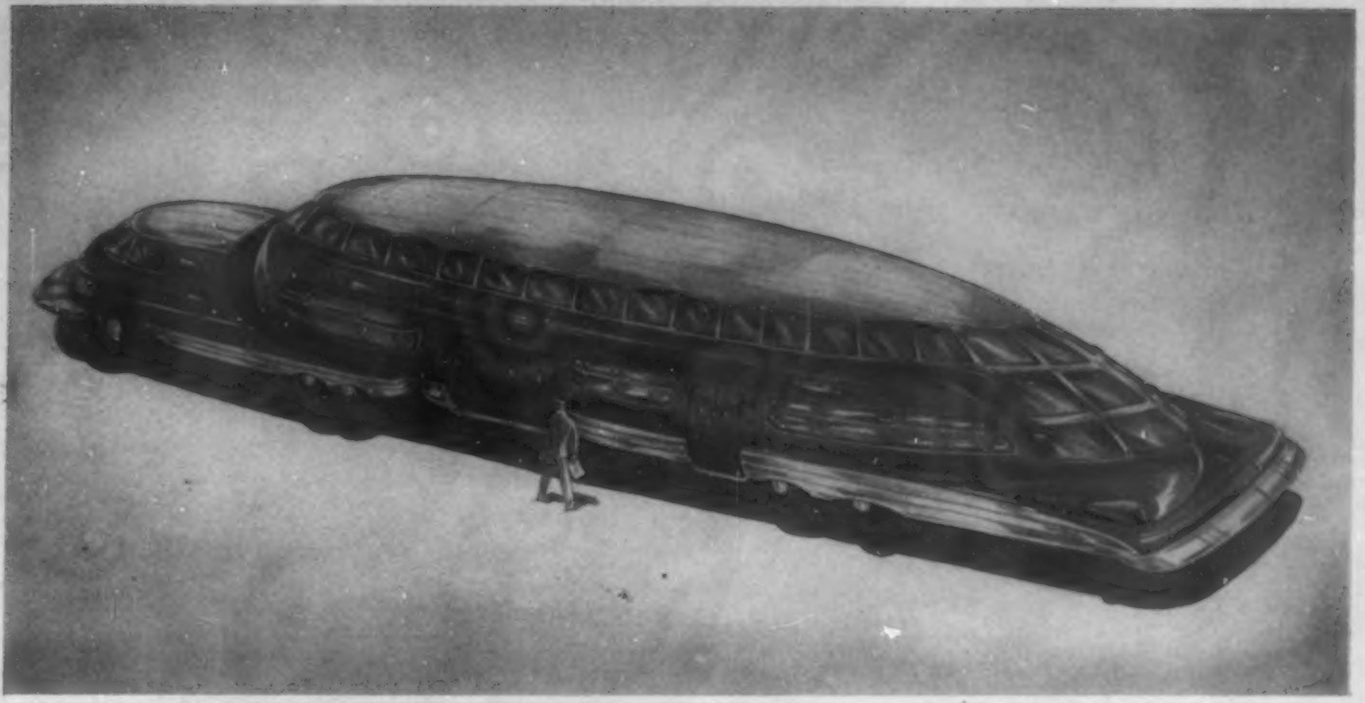
FAST . . . initial job preparation and set-up time is reduced to the minimum. Accurate performance of the machine saves operator's time and rapid production of intricate molds and dies is the result.

Write for Bulletin No. 1002C for complete information on the Milwaukee Rotary-Head Miller and the accurate and rapid production of all types of molds and dies.

Rotary Head Milling Machine
•
Autometric Jig Borers
•
Center Scope

Kearney & Trecker Products CORPORATION
Milwaukee, Wisconsin
Subsidiary of Kearney & Trecker Corporation

Milwaukee Face Mill Grinder
•
Milwaukee Midgetmill
•
Milwaukee Speedmill



Design for plastics by Martial & Scull, New York.

LOOK AHEAD WITH DURA

for Plastic Fabricating

Postwar plans leap to the fore in this realistic design by Martial & Scull, prominent New York design consultants. Numerous acrylic windows enhance the riding pleasure of this two-tier modern chariot. Interiors: compartments, bedrooms, or reclining chairs, made excitingly beautiful and restful with modern plastic appointments.

Magnificently different — is this bus of tomorrow. Dura can help you solve tomorrow's problems today through its practical experience in fabricating plastics. Today's landing craft, planes, armored vehicles are carrying Dura's products far afield — a forerunner of Dura leadership in the world of tomorrow.

Consult Dura first on your postwar plans.

dura plastics, inc.

1 west 34 street. new york 1, n. y.

MEMBER SOCIETY OF THE PLASTICS INDUSTRY SPI

Custom fabricating specialists to the aviation, electronic and shipbuilding industries.

★ LITTLE THINGS, TOO, ARE VITAL!

For example, the Gosport Helmet, used by the U. S. Navy provides an intra-plane communication system between instructor and trainee . . . a vitally important hook-up! Replacing sheet brass, the plastic parts which serve the speaking, hearing and connecting elements comprise a specially formed mouthpiece, a pair of ear terminals and a tube union. These were *Sterling* molded of acetate butyrate, by two completely automatic dies. The holes were cored without flash. No machining was required. All edges were smooth . . . the mouthpiece being desirably flexible, shape-retaining and superior to metal. ★ At *Sterling* much care is given to vital trifles. It's *Sterling's* way to mold them better in every way. Inquiries invited.

STERLING PLASTICS CO.

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WE DEVELOP AND MANUFACTURE WATER DISPERSED MATERIALS

If you are a manufacturer who dips, coats or impregnates, or uses adhesives or rubber-like materials, let us know your requirements. It is likely that we can develop for you a water dispersed elastomer or composition that will meet your specific needs for an economical rubber-like material.

Dispersions Process, Inc.

under management **UNITED STATES RUBBER COMPANY**

symbolizing research and development in water dispersions

US

1230 SIXTH AVENUE, NEW YORK 20, N. Y.


Your plastics home
—OR, PAYING RENT IN A DREAM WORLD
The Sunday supplement boys have got hold of plastics and they've been building everything out of plastics including your postwar home. Strictly from words, of course.
Now you and I know better. We know that plastics were making definite inroads into architectural and structural applications before the war. Extruded plastics were being used in everything from terazzo floors to plumbing. But we know plastics can't do *everything!*
DETROIT MACOID has played a pioneering development role in the use of extruded plastics in building. We have developed and produced some of the outstanding plumbing and wallboard applications in this field. We are working now with designers for after-the-war production.
We also do injection molding.
DETROIT
MACOID
CORPORATION
12340 Cloverdale Ave.
Detroit, Michigan
SOCIETY OF THE PLASTICS INDUSTRY
SPI
ORIGINATORS OF DRY PROCESS PLASTIC EXTRUSION

INVESTIGATE THIS VERSATILE DU PONT PRODUCT

POLYVINYL ALCOHOL

A FLEXIBLE, HIGH TENSILE STRENGTH WATER-SOLUBLE RESIN

WATER SOLUBILITY does away with the need for expensive organic solvents. Polyvinyl alcohol, supplied in the form of a fine powder, dissolves easily in hot or cold water, depending on the type and grade.

HIGH STRENGTH AND FLEXIBILITY are characteristics of this resin which are not often found in water-soluble products. Tensile strength and flexibility can be varied with plasticizers.

RESISTANCE TO GREASES AND COMMON ORGANIC SOLVENTS permits use of Polyvinyl Alcohol plastics in applications where many other high-strength plastics would be unsuitable.

GAS IMPERVIOUSNESS of Polyvinyl Alcohol should be of particular interest to manufacturers of food packages. PVA is highly impervious to air and most common gases except water vapor and ammonia.

TASTELESS, ODORLESS, NON-TOXIC, unmodified Polyvinyl Alcohol has undergone tests which indicate it is non-toxic and is not irritating to the skin.

ADHESIVES AND BINDERS which are strong and flexible can be made from PVA itself or by blending other products such as starch, casein, rubber, latex and protein. The remoistenable adhesives are of particular interest because of their non-blocking characteristics.

EMULSIONS of a wide variety of materials may be prepared with Polyvinyl Alcohol alone, or in combination with other emulsifying agents. PVA is effective over a wide pH range and in the presence of substantial amounts of electrolytes.

MODIFICATIONS of its properties are possible with plasticizers, extenders, gelling agents, colors, flame-retardants, etc.

GRADES OF AVAILABILITY—Several grades of Polyvinyl Alcohol are available, each with different physical and chemical properties, permitting a selection of the grade best suited to specific requirements. At present, sales of Polyvinyl Alcohol are directed by W.P.B. allocation. Small amounts, however, are available for research work. For information, mail coupon.

E. I. du Pont de Nemours & Co. (Inc.)
Electrochemicals Department
Wilmington 98, Delaware

Please send me information on Polyvinyl Alcohol.

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BETTER THINGS FOR BETTER LIVING ... THROUGH CHEMISTRY


INJECTION MOULDING
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Pressure Switch • Magnetic Starter

All units mounted on Reservoir Base

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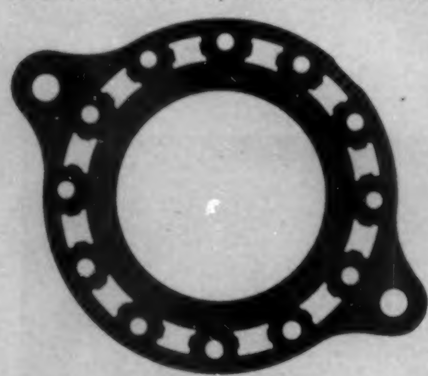
COMMUNICATIONS MUST NOT FAIL!

In the cold of the North ... in the heat of the South ... in the humidity of the jungles ... in the dryness of the desert!

BEACH OFFICER, WITH WALKIE-TALKIE RADIO, COORDINATES ATTACK DURING AFRICAN CAMPAIGN.



CONTINENTAL-DIAMOND

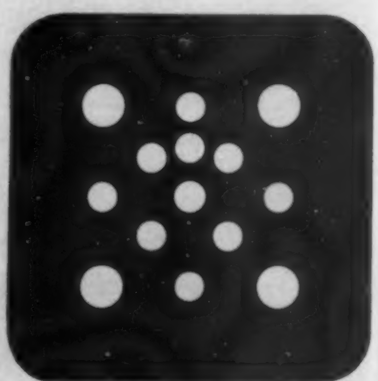
Electrical Insulating Materials are engineered to retain stability from 70°F. below zero to 160°F. above zero. Bulletin GF gives complete technical data on all C-D products Dilecto—Dilectene—Vulcoid—Diamond Fibre—Celoron.

THIS DILECTO

part used in Signal Corps equipment is an intricate punching ... engineered to stand up under severe mechanical stress as well as electrical and thermal extremes.

THIS DILECTENE

part used in Military radio equipment has especially low loss factor ... and its electrical and mechanical properties are stable over a wide range of frequencies.



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DISTRICT OFFICES: New York - Cleveland - Chicago - Spartanburg, S. C.
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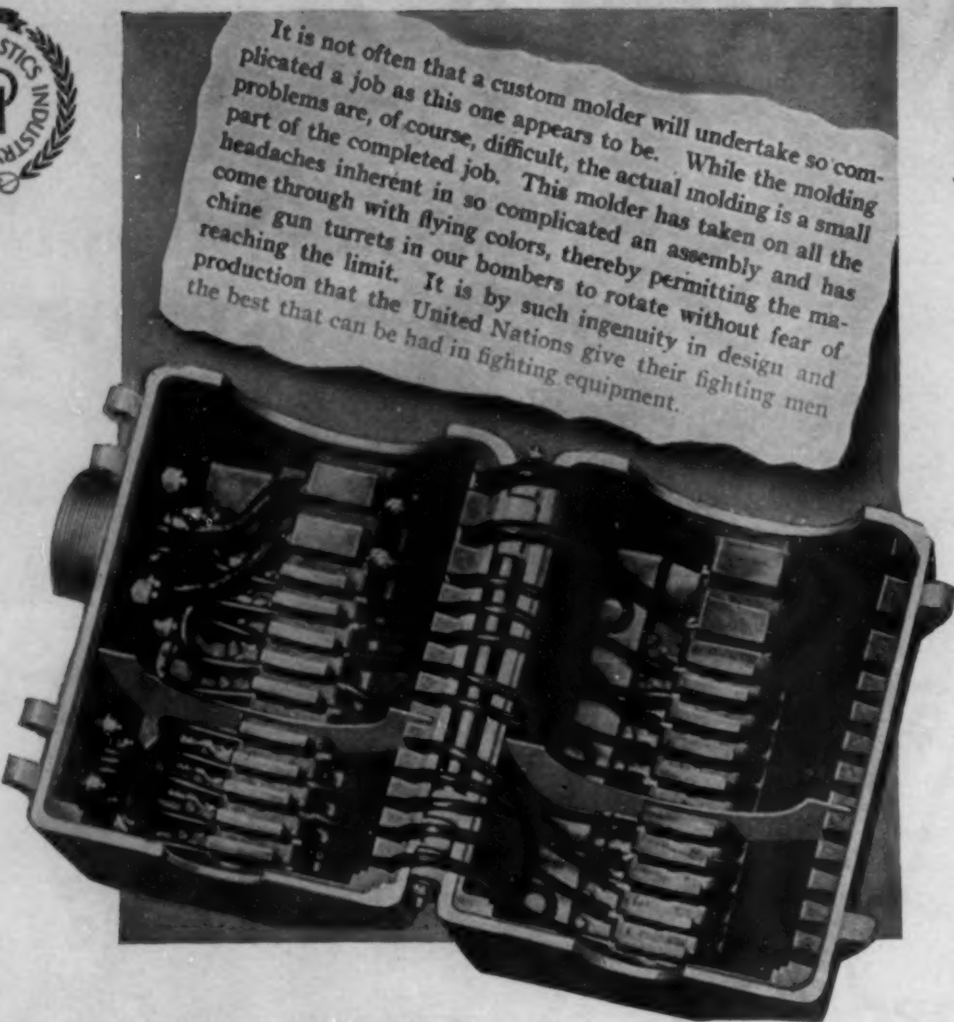
Continental-Diamond FIBRE COMPANY

Established 1895.. Manufacturers of Laminated Plastics since 1911—NEWARK 28 • DELAWARE

NO. 2 ROYLE PLASTICS INSULATING MACHINE

SOCIETY OF THE PLASTICS INDUSTRY · SPI



. . . quotation from article in prominent plastics publication.

PM

THE SYMBOL OF ENGINEERING EXPERIENCE AND MOLDING SKILL

ASSEMBLIES—

Above is part of a transmission unit used to power revolving turrets in military aircraft. The view aptly illustrates what we mean by "engineered plastics." The molded stator is metal plated, incorporating the best features of plastics and metals for the job at hand. We deliver the assembly complete with rotor and connections, ready for installation.

Our design engineers and molders are fully experienced in the use of plastics with complementary metals. Working with combinations of these materials, we have developed some original techniques which have solved a number of product problems.

If you are making war products that may be benefited through molded plastics, or if you are considering postwar applications, get in touch with us now.

For handy and helpful facts on our plastics services, write for free Folder File MP 9.

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INCORPORATED

STAMFORD, CONNECTICUT

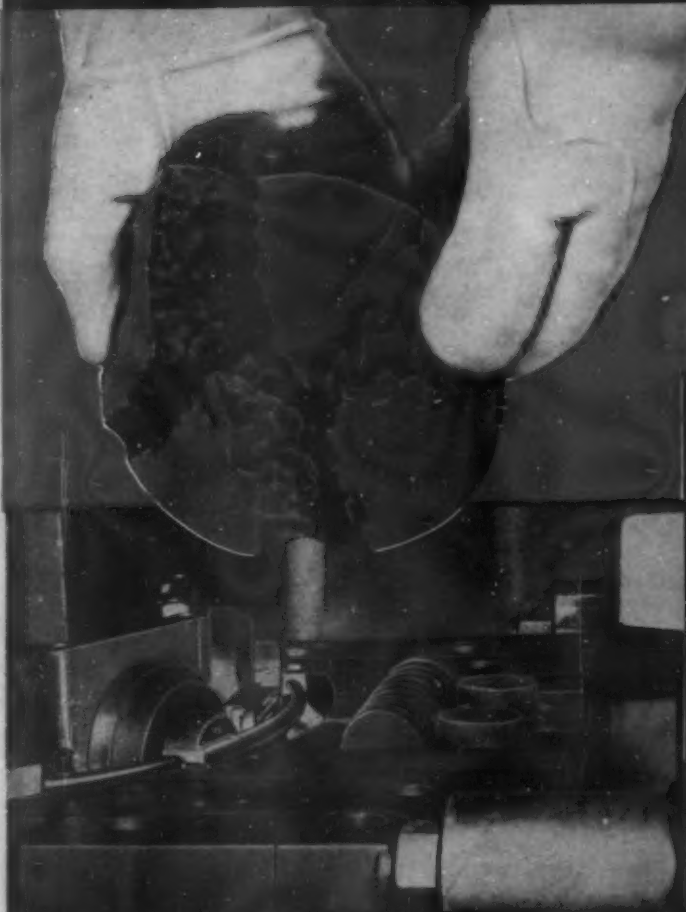
DESIGN ENGINEERING • MOLD MAKING • INJECTION & TRANSFER MOLDING • COMPLETE ASSEMBLY

Representatives: DETROIT 2—805-06 New Center Bldg. • NEW YORK 1—19 West 34th St. • LOS ANGELES 35—1440 So. Robertson Blvd. CANADA—A. & M. Accessories Ltd., 19 Melinda Street, Toronto; 744 West Hastings Street, Vancouver; 1405 Bishop Street, Montreal

COMPLETE PLASTICITY!

-MEGATHERM-*

CUTS MOLDING TIME 90%



▲ *The molded handset ready for ejection from the mold after the 30 second perfect cure.*

◀ *Megatherm heated preforms in press transfer chamber just before closing.*

Photos Courtesy Shaw Insulator Co.

Federal Industrial Power Tubes, give power and performance to Megatherm and other industrial heating equipment.

Molding time on these telephone handsets was reduced from five minutes to 30 seconds with Megatherm.

In addition to rapid molding Megatherm provided a complete and uniform cure which was free of all internal stress.

Megatherm is doing plastic preform heating *better* and *more quickly* than any other method. In many cases Megatherm has made a plastic molding job possible which could not be done by other methods.

Megatherm units are compact, and may be easily moved from one production line to another. One of the four standard models will fit your production needs. Megatherm is available in 3 KW, 7 KW, 15 KW and 25 KW output capacities.

Cost of operation is low, the popular 3 KW Megatherm has a power cost of 5¢ per hour.

If you have a plastic preheating problem, now is the time to talk about it with Federal.

Federal Telephone and Radio Corporation

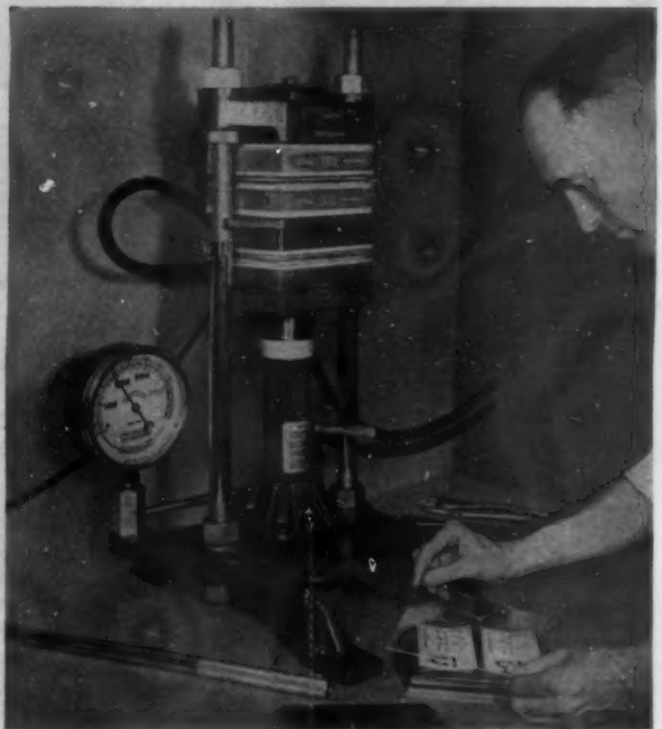
INDUSTRIAL ELECTRONICS DIVISION Newark 1, N. J.

An IT&T ASSOCIATE

*REG. U. S. PAT. OFF.

THE CARVER LAMINATING PRESS

NO *illegal* ADMISSION



The Carver Laminating Press is available for prompt deliveries. Information on request.

Vital operations are safeguarded in war plants and in government offices and bases, here and abroad, by use of tamper-proof identification cards and badges, produced on the Carver Laminating Press. These identification forms, containing individual photographs and personal data, are laminated between sheets of cellulose acetate, with edges permanently welded under heat and pressure. The cards, secure in their plastic sheath, cannot be altered or removed.

The Carver Laminating Press handles stacks of 6 laminations at a time between 6x6 electrically heated platens. Each stack holds 12 cards, 24 or more badges, all cured in one heating and cooling cycle under pressure. In 3 models: No. 122 for 150 to 200 cards per 8 hours; No. 124, 300 to 400; and No. 126 for 600 to 800. Each handles twice as many badges in the same time.

Distributors

THE FOLMER GRAFLEX CORPORATION

Rochester 8, N. Y.

We do not supply cards, badges or plastic materials. These may be obtained through regular supply sources.

FRED S. CARVER
HYDRAULIC EQUIPMENT
343 HUDSON ST., NEW YORK 14

Boonton Molding Company's own production "The Shape of Things to Come" is not a movie like you have ever seen before. We waste no adjectives or any of your time in describing it.

It is quite simply a movie about molding. We made it to prove a point—namely, that molding plastics is not a simple business. Incidentally, we also think we prove another point: that we know how to mold them.

As far as we know, it is the first Kodachrome motion picture produced by a molder about molding. It has no love interest—no cow-boys or Indians. It is interesting, tho. People in and out of the plastics industry have told us that they like it. More, they have demonstrated their opinion by requesting showings of the picture.

Like everything else, there is a shortage of motion picture film, especially Kodachrome. Therefore, right now we only have a few prints so far and you may have to wait in line a bit before you can get the film. Since it doesn't cost you anything and since you might learn something from it, why not take a chance and ask us? Just write to our Film Booking Dept. (just goes to show how complicated the plastics business is getting when you have to put in a film booking department).

ARMY E NAVY

BOONTON MOLDING COMPANY

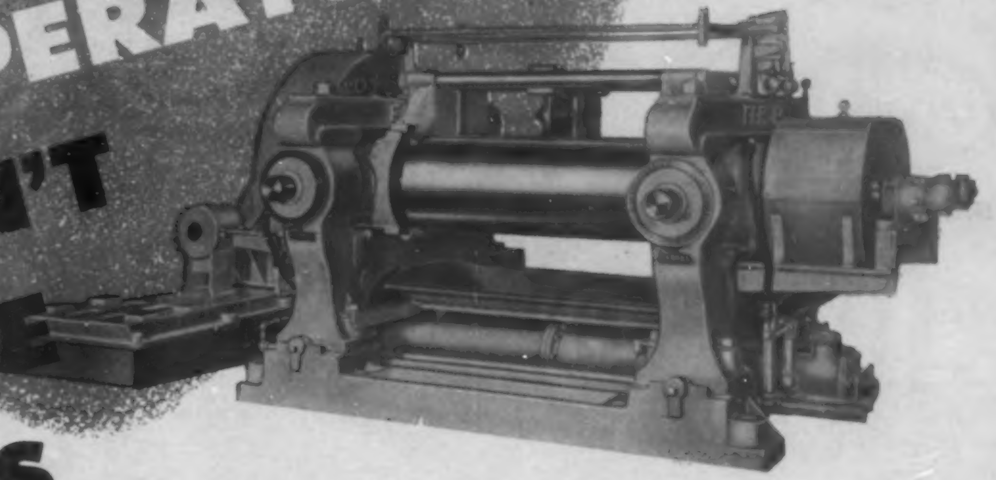
MOLDERS OF PLASTICS · PHENOLICS · UREAS · THERMO-PLASTICS

BOONTON · NEW JERSEY · Tel. Boonton 8-2020

NEW YORK OFFICE

Chanin Bldg., 122 East 42nd Street, New York 17, N. Y., MUrray Hill 6-8540

HIGH TEMPERATURES WON'T FAZE THIS MILL



IT has been *designed* to process plastics that require high temperatures for converting and mixing.

The rolls are chamber bored, and fitted with a special type of stuffing box to provide proper temperature control. The water-cooled journal boxes carrying the rolls are lubricated by a continuous circulating system which includes a cooler and strainer.

To provide maximum strength, Meehanite, a processed iron having superior physical properties, is used for the housings, bedplate and bull gear. A patented shear pin safety device, fitted between the adjusting screws and front roll boxes, prevents breakage of housings and other parts in case of overloading.

When the mill is to be used for stocks which are sensitive to contamination, the rolls can be chrome-plated and the adjustable guides and mill pan made of non-corroding metals. A special ratchet adjustment for raising the guides permits thorough cleaning of the rolls as well as the guides themselves.

These "designed-for-the-job" mills are available in a complete range of sizes, from 8" x 16" for the laboratory up to 28" x 84" heavy duty machines for factory production. Write for complete information.

F-B PLASTICS MACHINERY

- Banbury Internal Mixers
- Roll Mills
- Converting, Mixing and Sheeting Rolls
- Calenders
- Extruding Machines
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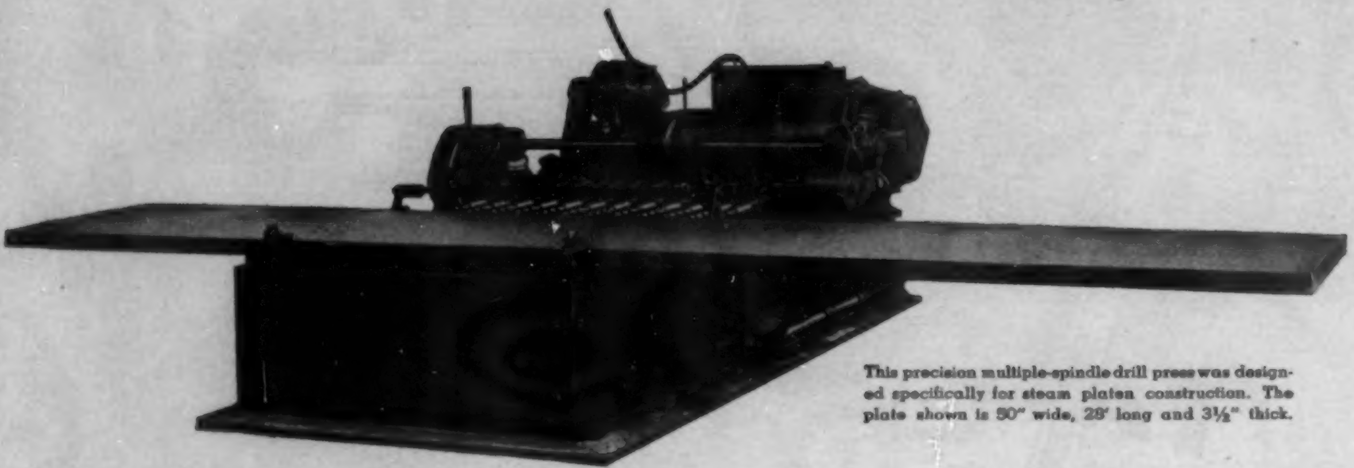

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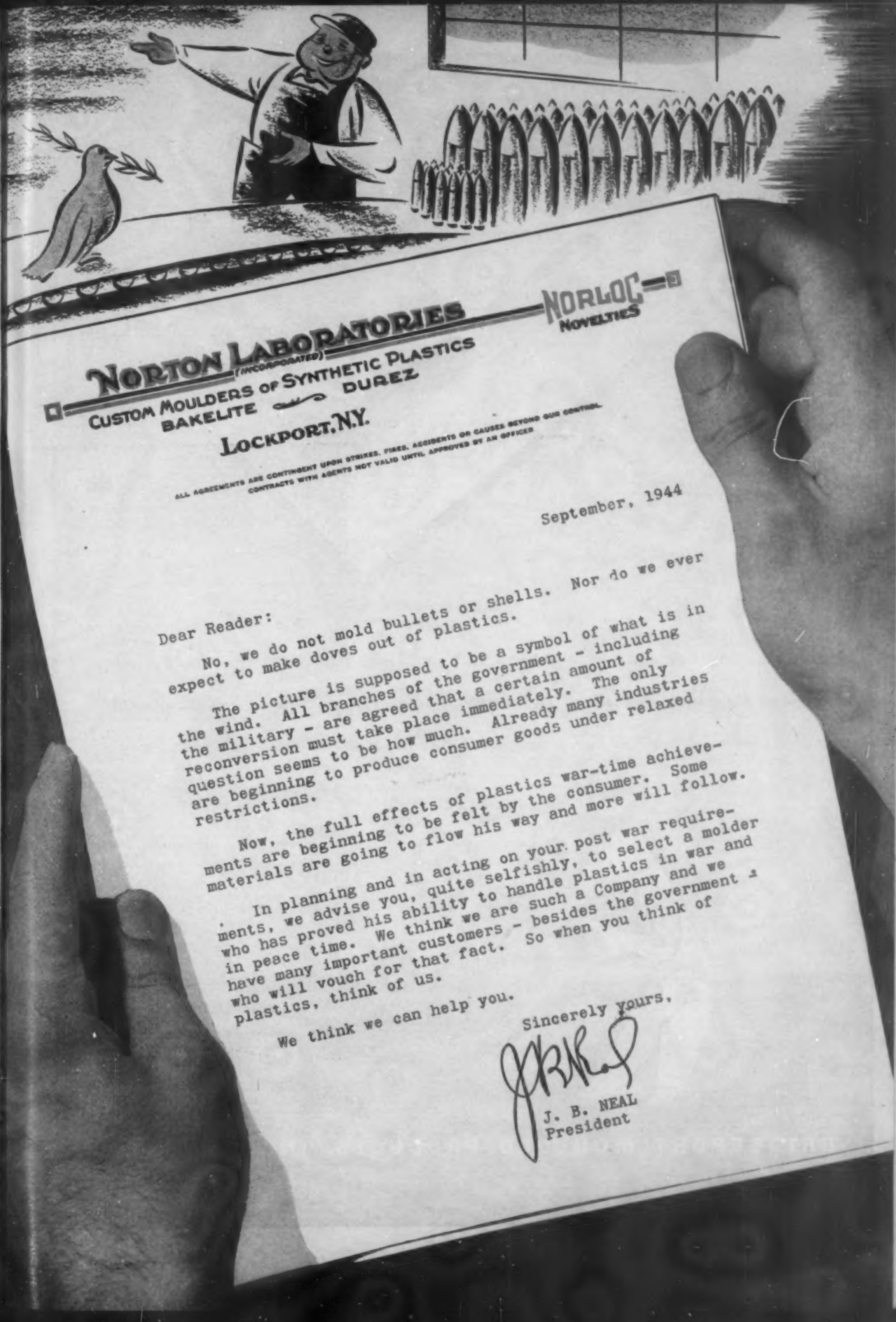

September, 1944

Dear Reader:

No, we do not mold bullets or shells. Nor do we ever expect to make doves out of plastics.

The picture is supposed to be a symbol of what is in the wind. All branches of the government - including the military - are agreed that a certain amount of reconversion must take place immediately. The only question seems to be how much. Already many industries are beginning to produce consumer goods under relaxed restrictions.

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In planning and in acting on your post war requirements, we advise you, quite selfishly, to select a molder who has proved his ability to handle plastics in war and in peace time. We think we are such a Company and we have many important customers - besides the government - who will vouch for that fact. So when you think of plastics, think of us.

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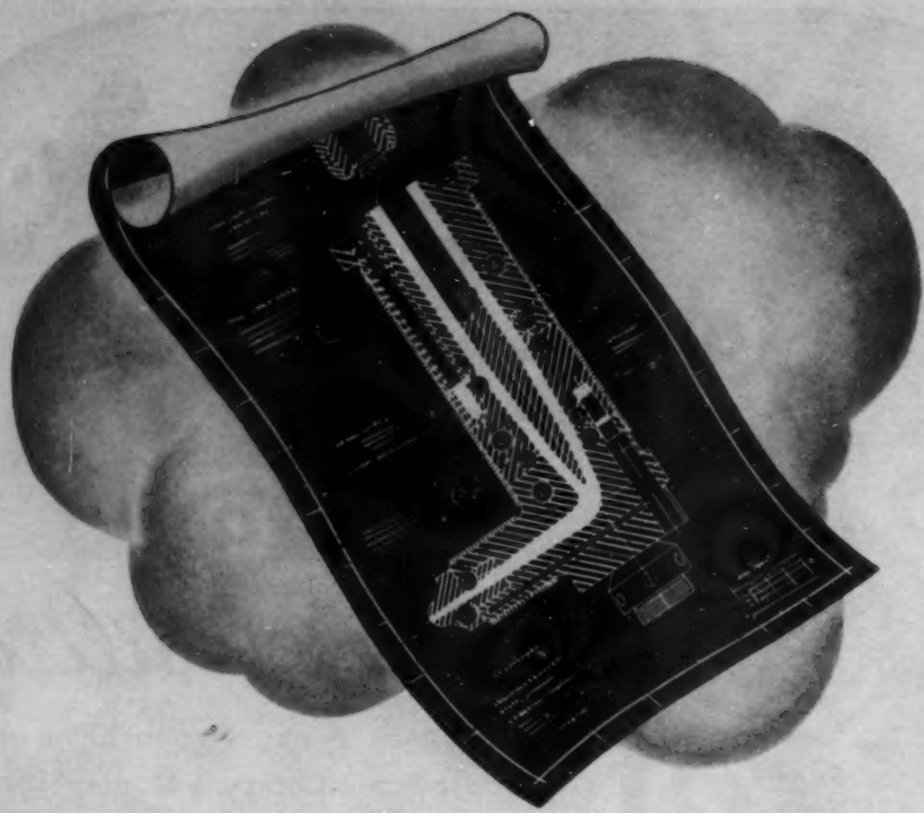

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Take a look at the mechanical drawing shown above. It will give you some inside information on the Lester vertical injection cylinder.

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Moldings thus produced are dense and homogeneous throughout, with a structural stability which minimizes cooling shrinkage and makes it possible to attain *and hold* tolerances as fine as $\pm$ .001. Their structural strength is greater than that of ordinary moldings, they are less likely to contain shrinkage strains caused by uneven pressures in molecular structure, their surfaces are hard, smooth and free of weld marks, and they have a high resistance to thermal shock. In applications where structural, tensile, compressive, impact, shear or flexural strength is a factor, they will actually and demonstrably outperform castings made on other molding machines.

But strength is only one requirement of a plastic molding; speed of production is important, too. Our October advertisement will tell how Lesters step up production rates; watch for it.

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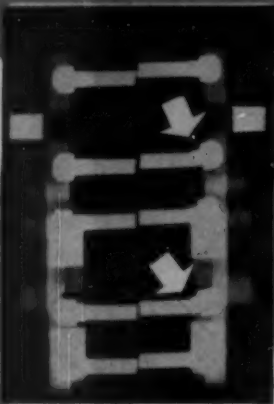

*BENT METAL INSERTS: Unretouched Searchray radiograph of a molded plastic assembly reveals bent metal inserts.

*LARGE VOIDS: Unretouched Searchray radiograph showing distribution of large voids around the periphery of a large brass insert.

*POROSITY (A) AND CURING GRADIENT (B): A 5X magnification of an unretouched Searchray radiograph showing porosity and curing gradient from core to surface in a phenolic molded piece.

NORELCO Searchray (industrial X-ray) equipment pays its way in plastics plants by detecting hidden faults in finished and semi-finished products. In this way, Searchray protects quality, reduces rejections, promotes uniformity and provides a check on molding techniques. Searchray guards against delivery of defective products to your customers. It creates good will by minimizing rejections, loss of time and labor.

Shockproof, rayproof and completely self-contained, Searchray gives you all the benefits of *non-destructive* fluoroscopic and radiographic X-ray inspection *without* the expense and inconvenience of a space-consuming, lead-lined room. Easily, safely operated by quickly trained factory personnel, it reveals internal details hidden to the eye on most types of molded products. Voids, inclusions, case hardening, shrinkage, the proper placement or absence of metal inserts are quickly disclosed. When used as a guide to quality, Searchray shows up incorrect molding temperature, pressure, cycle or formula through changes in the internal characteristics of the molded pieces.

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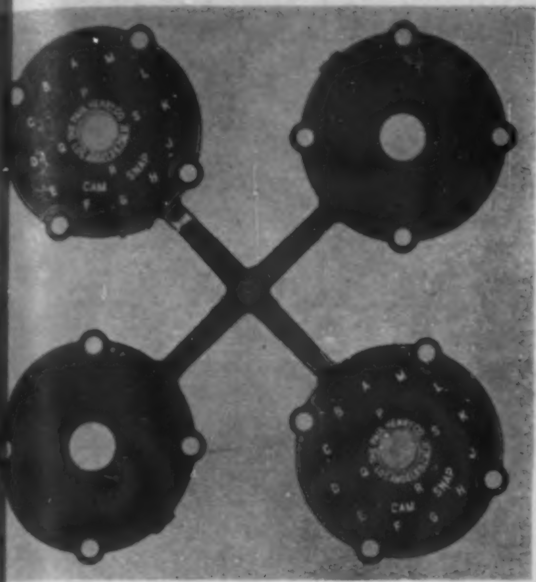

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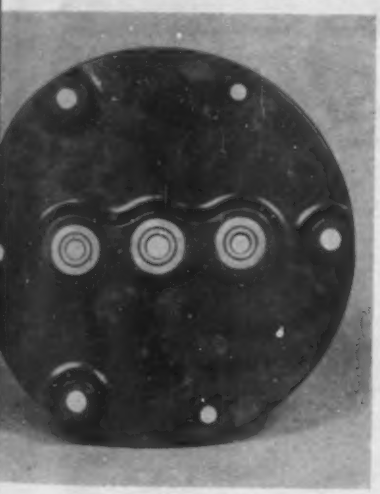

The interesting Aircraft Assembly part depicted on the left was molded by WILLARD CROFUT COMPANY, Los Angeles, Calif. Molded from MAKALOT #93-C Natural, this piece is featured for its improved strength plus its adaptability for use with inserts.

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MODERN PLASTICS
SEPTEMBER 1944 VOLUME 22 NUMBER 1

The case for synthetic textiles

Synthetic fibers are here to stay. Technological improvements may be expected and the postwar era will see a greatly increased production resulting in lower prices. Changes are occurring with such rapidity in the industry that the new developments of today are outmoded tomorrow

THIS is Part I of a discussion of synthetic textiles and their place in the economic structure of the textile industry. Part I will cover the synthetic fibers, and Part II in a later issue will cover coated fibers, coated fabrics and fabric finishes.

As in other industries, chemists have startled the world with brilliant successes in the synthetic fibers. Nylon is the outstanding one, at once the darling and envy of the synthetic world (and of the natural fiber industry, too), although rayon is the most prolific in volume and most important in world production. Nylon has had the economic advantage of having been perfected before it was introduced to the public; it sprang mature and full-fledged into the textile world, whereas rayon went through its growing pains in public—through its adolescence in the shiny silk stage of the twenties, through its political struggles with the Federal Trade Commission caused by its usurpation of the words, "silk," "artificial silk," etc., and through technological experiments and developments. In short, rayon still suffers from having been first marketed in a highly imperfect state, whereas nylon was perfected for its consumer uses before it was introduced to the public. Rayon and nylon are the best established of the synthetics, although other synthetic fibers such as vinylidene chloride and casein fibers were in commercial use before the war in specialized markets, and many others will be available after the war.

It is a present vogue among textile men to write of the battle of the fibers, meaning the displacement of one fiber by another from its place in the economic hierarchy of textiles. The progress of "the battle of the fibers" occupies the attention of textile forums and magazines. Among the natural fibers—silk, linen, cotton, wool, jute, etc.—this battle is centuries old; it is the often-repeated story of the fight of a vested interest to protect its investment against the onslaughts of a cheaper or better adapted fiber. The prewar standing of the major fibers in their battle for world supremacy may be seen in Table I.

In a struggle between two otherwise equal competitors in the battle of the fibers, price is the determining factor. Indeed, unless there is wide disparity in the performance of two fibers in their consumer uses, the inferior wins

1—*Floating to earth under their white nylon chutes, U. S. paratroopers land in Tunisia. Rayon cargo chutes carry weapons and ammunition, their colors indicating the nature of the load. Diorama designed and built by Louis Paul Jonas*

KODACHROME, COURTESY TEXTRON, INC.

when fighting with the weapon of lower price. But despite this overwhelming advantage of lower price a vested interest wages a long war before yielding to an interloper in its established markets. One of the most classic delaying actions in history was fought by the silk interests of ancient China which prevented the establishment of cotton as a major fiber for fifteen hundred years after its introduction in 500 B. C. (Even as late as the 13th Century, Marco Polo reported that cotton was known only in Fokien Province.) Similarly the rise of the great Manchester cotton trade in England was bitterly fought by the silk and wool interests, and the silk weavers temporarily stifled their cotton competition in the fashion market with the passage of the Calico Act, an act prohibiting the printing of cotton cloth. In our country (and throughout a large part of the textile world) the vested textile is cotton. Cotton accounts for 80 percent of the U. S. total textile poundage and absorbs the work of more than 13,000,000 Americans who are directly dependent on cotton for a living. In addition, although we are the largest producers of cotton in the world, cotton further protects itself with a tariff wall.

The newcomers in the battle of the fibers are the synthetics which, being products of the 20th Century, have entered the lists at relatively recent date, but so impressive has been the performance of rayon and nylon and the promise of many newer fibers that some textile authorities predict their future hegemony. Cotton men, conservative and traditional-minded, laugh at these predictions. Their confidence is based on the price factor—on the "inherent" low price of cotton and the "inherent" high price of most of the synthetic fibers. Undoubtedly the battle of the fibers in the postwar world will be decided, as it has been in the past, on the issue of price as well as performance, but there is little to suggest that the price of American cotton is inherently low. On the contrary, its history has been marked by extreme fluctuations in price, while the price of rayon, its nearest competitor among apparel fibers, has shown extreme stability and a continuous downward trend. As the price trends of the postwar synthetics may be expected to follow that of rayon, the price history of rayon, in contrast to cotton and wool, is of interest. Rayon price has dropped in a steady curve from a high of $6 a pound in 1920 (for 150 denier viscose) to 55 cents in September 1941 where it remains today; and acetate rayon and staple fiber have followed the same price pattern. Production

TABLE I.—WORLD FIBER PRODUCTION, 1938

	lb.
Cotton[a]	13,909,800,000
Raw wool (greasy basis)[b]	3,910,000,000
Jute[b]	2,788,000,000
Rayon:[b]	
Filament	944,000,000
Staple	933,000,000
Total	1,927,000,000
Flax[b]	1,767,000,000
Raw silk[b]	109,000,000

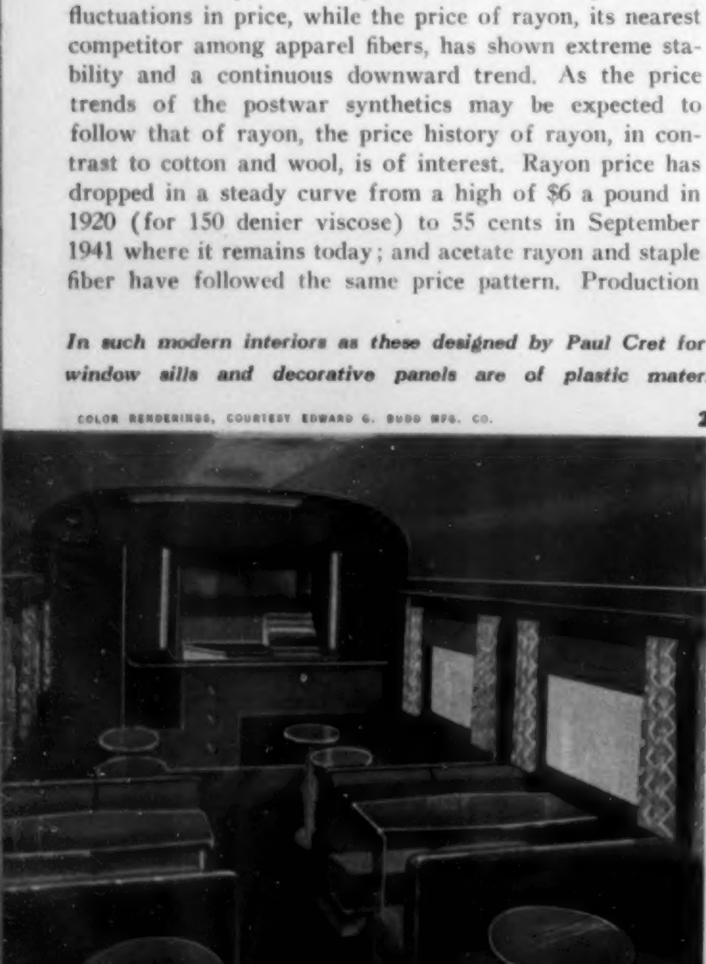
[a] Dept. of Agriculture
[b] Textiles Unit, Div. of Industrial Economy, Bureau of Foreign and Domestic Commerce, U. S. Dept. of Commerce.

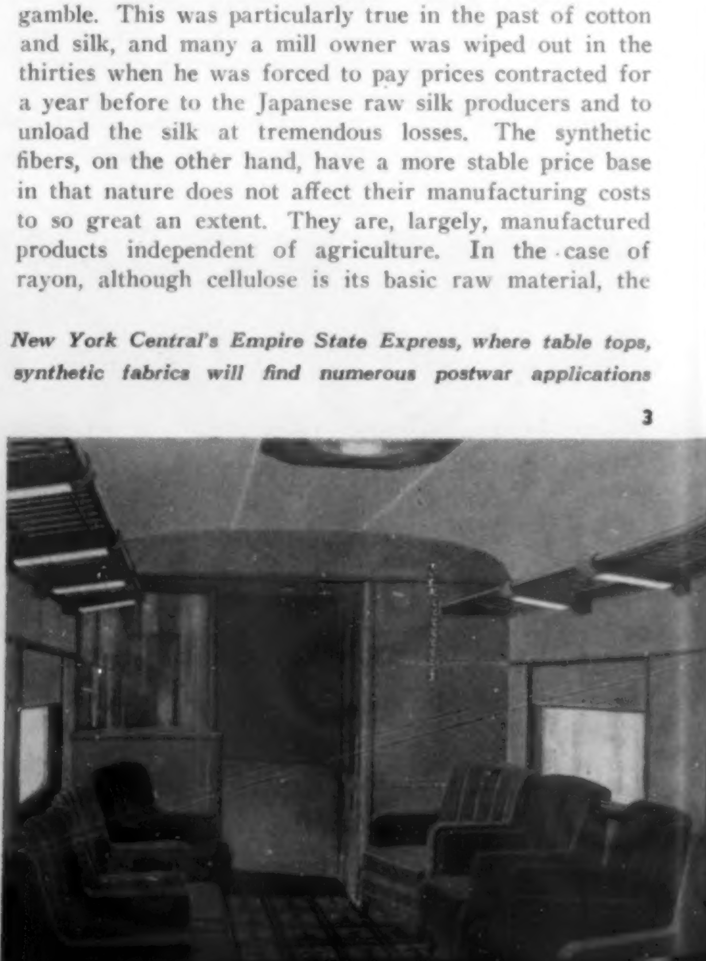
during these years mounted from 10,125,000 lb. in 1920 to a record output of 663,600,000 lb. (yarn and staple fiber) in 1943, putting rayon in second place among American apparel fibers (cotton, rayon, wool and silk) with 10 percent of the total consumption. Wool, its nearest competitor, captured only 9.3 percent of U. S. consumption in 1943. In contrast to the stability of rayon prices during the years 1920 to 1943, the prices of cotton and wool were markedly erratic. Cotton dropped from 34 cents a pound in 1920 to 6 cents in 1932; during the thirties it fluctuated between 9 cents and 12 cents, and since the war it has risen from its 1940 price of 10 cents to its current level of about 21 cents. During the same period wool dropped from $1.66 a pound in 1920 to 66 cents in 1932; in the late thirties its price fluctuated between 70 cents and 90 cents a pound, rising to its present price of $1.20.

Such price fluctuations are characteristic of the natural fibers, whose price depends on fortuitous accidents of nature and agriculture—on climate, crop, and Government subsidies—or on the actions of foreign governments. Thus lack of rainfall in some remote part of the world casts a gloom over the fiber markets, and the uncertainty of the future makes the buying of the natural fibers a gamble. This was particularly true in the past of cotton and silk, and many a mill owner was wiped out in the thirties when he was forced to pay prices contracted for a year before to the Japanese raw silk producers and to unload the silk at tremendous losses. The synthetic fibers, on the other hand, have a more stable price base in that nature does not affect their manufacturing costs to so great an extent. They are, largely, manufactured products independent of agriculture. In the case of rayon, although cellulose is its basic raw material, the

In such modern interiors as these designed by Paul Cret for the New York Central's Empire State Express, where table tops, window sills and decorative panels are of plastic materials, synthetic fabrics will find numerous postwar applications

COLOR RENDERINGS, COURTESY EDWARD G. BUDD MFG. CO.





cellulose is reported to be only a small item in the cost of the completed rayon yarn. Further, most of the cellulose now used is wood pulp; *Pulp and Paper Industry* for May 1944 states that in 1943, 84 percent of all the cellulose used in the entire industry (viscose, cuprammonium and acetate) was *wood* pulp and only 16 percent cotton linters. Wood, although a product of nature, is a more stable source of supply than cotton, and there is the added fact that the wood pulp used in the rayon industry comes from three different sources—Western hemlock, Southern pine, and small amounts of Canadian spruce—creating a diversification of supply. This diversification enables the companies to shift their source of supply during periods of agricultural shortages, as the chief users of cotton linters (the acetate and cuprammonium industries) are said to have done in this war. The other principal raw materials of rayon manufacture are not agricultural products, and this is generally true of all of the synthetics.

Another element in the stability of rayon prices is the closely integrated production system of the industry, and here again the synthetics lend themselves better to an integrated production system than do the natural fibers whose industry is traditionally piecemeal. Segregation of the successive processes of trade and manufacture, and their performance by separate units is one of the outstanding characteristics of the textile industry as a whole, always excepting the rayon industry which to a great extent has eliminated middlemen in the sale of yarn to the mills. Rayon producers sell directly to the mills rather than through the maze of brokers, assemblers and commission merchants that characterizes the cotton and natural fiber industry; and there is a tendency toward close supervision of the end products, some companies even maintaining their own weaving mills.

Turning from the all-important factor of price to the properties and adaptability of the synthetic fibers, their future was brilliantly presented in an article in *Textile World* (September 1943) by Douglas Woolf and Winn Chase. The authors predict that in the immediate postwar years synthetics will encroach greatly on the territory of the natural fibers, and that in the not-too-distant future they will displace them altogether. Quoting Dr. E. R. Schwarz of Massachusetts Institute of Technology, they point out that "the widely used natural fibers were not designed by nature for spinning into yarn nor for conversion into fabrics," but in the era we are entering textile fibers will be made to order to suit particular needs and purposes. Their conclusion is that "It is apparent to any objective observer of this problem of natural vs. synthetic fibers that the conformability of the former is limited by certain fairly rigid structural characteristics, while the conformability of the latter is limited only by the degree of imagination and knowledge of the chemist and physicist working together." This versatility and conformability of the synthetic fibers enabled them to take the offensive long before the war, Mr. Woolf says, on the first of three major fronts which can be distinguished in the battle of the fibers. The first front was that of the synthetics vs. the natural fibers. Just before the war a second front was developing: that of synthetics vs. synthetics, an intra-industry competition between the completely synthetic fibers, such as vinyl resin and nylon, and regenerated cellulose fibers, such as viscose and cuprammonium rayon, or regenerated protein fibers such as casein.

Mr. Woolf's argument is that because what he calls "the completely synthetic fibers" are a step further removed from animal or vegetable sources than the regenerated fibers they are more conformable to man's wants in textiles and, therefore, they will ultimately (though not for several years to come) displace the regenerated fibers. A minor battleground of the second front is the skirmish between rayon staple and continuous filament which, the authors believe, is tied up with the battle on the third front—that of completely synthetic fabrics such as nylon, made by the old-school methods of spinning and weaving, vs. that of completely synthetic fabrics made without benefit of the spinning frame and the loom, such as the sheet plastics made into raincoats, shower curtains, etc., and the film and calendered materials. This third front is deep in the economy of the industry, tied up as it is with a huge and countrywide investment in mill equipment.

This thesis brilliantly presents the case for synthetic fibers and synthetic fabrics. Persuasive as is its assumption that the man-made fibers and synthetics more exactly conform to man's needs and wants because they were brought into being with man's needs and wants in mind, it is by no means agreed that they *do* conform more nearly to man's wants. In the case of many of the synthetics, intention to improve on nature is not, as yet, performance, though the future will undoubtedly bring improvements and lowered price. Many early tech-

2—Forward end of tavern lounge car, showing bar and tavern seating. 3—Parlor car with vision panel at corridor end. 4—Card playing sections of observation lounge car. 5—Central section of dining car shows mirrors of acrylic plastic

4

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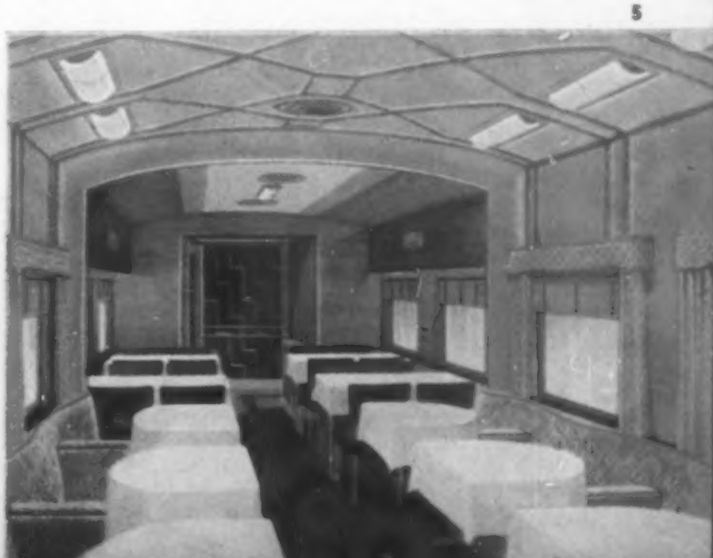

nological problems of the synthetic fibers have now been surmounted. Initially, for example, the smooth surfaces of the continuous filament synthetic fibers created a serious problem for spinning machinery adapted to the rough surfaces and ends of the short staple natural fibers, but this like other technological problems which the synthetics are now overcoming, are technical problems incidental to any pioneer industry.

If the natural fibers do not exactly conform to man's wants, they do supply his basic textile needs—warmth, suppleness and absorbency—to a remarkable degree, and in the opinion of many practical mill men, the future of the newer synthetics (excluding nylon and rayon) lies in combinations and blends with the natural fibers. Mr. August Hafner of Hafner Associates, Inc., expresses this typical and traditional view stating that, while the new fibers will revolutionize many new industrial fields, their chief future is in combination. We quote: "One of the greatest possibilities of the new thermoplastic yarns is in combination with the natural fibers and with each other, one supplementing the shortcomings of the other. Our belief as creators of fabrics is that a new vista is possible in the combination of these plastic yarns with the natural fibers—with wool, silk and cotton—the great natural fibers. Wool, the oldest of the fibers known to man, still has advantages which no other fiber can duplicate, as have cotton and silk. These three elementary fibers known for thousands of years will be used as much as ever, but new beauty can be added to them with plastic yarns." However, Dr. Harold De Witt Smith of A. M. Tenney Associates, in taking issue with this view of the synthetics as mere combination fibers, points out that the natural fibers are not ideal for all textile purposes. He believes that synthetic fibers have displaced silk to a large extent and will continue to do so and that there will be a much more limited displacement of cotton and wool.

On the basis of direct comparison of the properties of the synthetic fibers with their original prototypes—casein and the soybean fiber with wool, rayon with silk, etc.—it is important to remember that imitation of the natural fibers is only an early phase in the development of the synthetic fibers. The oldest of the synthetics have developed properties and characteristics of their own and carved out specialized markets in which they are superior to the natural fibers. Rayon is no longer the "artificial silk" of the twenties; it can be woven equally well to resemble wool or cotton, and it has developed new fabrics which establish it as a fiber on its own merits, as have nylon and some of the newer fibers.

In an effort to evaluate the synthetic fibers of the postwar and their place in the battle of the fibers, it may be useful to review their history and properties. Keeping in mind that the two basic essentials in which they must qualify are price and performance, how do the various synthetics line up for the battle?

Rayon

It is surprising to recall that as far back as 1889, Chardonnet's fabrics of artificial silk created a sensation at the Paris Exhibition. His rayon, the first to be produced commercially, was made by the nitrocellulose process. The nitrocellulose process has now been superseded by other processes of making rayon, and only Hungary and Brazil still maintain nitrocellulose plants. The four main methods of making rayon today differ mainly in the chemicals used to dissolve cellulose into a solution suitable for spinning. In each of the methods cellulose is dissolved into a solution, and the solution forced through the fine holes of spinnerets. On the other side of the spinneret it is coagulated into thread. The predominant method of producing rayon throughout the world today is the viscose method, so named because the honey-colored solution which passes through the spinneret is extremely thick and viscose. (The solution is cellulose treated with carbon disulfide in the presence of caustic soda.) In 1938 the viscose method accounted for 83 percent of the world production, while acetate accounted for 13 percent of the total and cuprammonium and nitrocellulose together for 4 percent (the great bulk of this being cuprammonium).

Rayons are sometimes classified as "regenerated cellulose fibers" and "cellulose derivative fibers." The first group, regenerated cellulose fibers, includes yarns and staple fibers that are essentially 100 percent cellulose in their final form. Viscose, cuprammonium, and nitrocellulose yarns and staple fiber make up this group. Cellulose derivative fibers include yarns and staple fiber which are chemical compounds of cellulose, such as acetate rayon whose content is said to be about three quarters

COLOR RENDERING, COURTESY J. GORDON CARR

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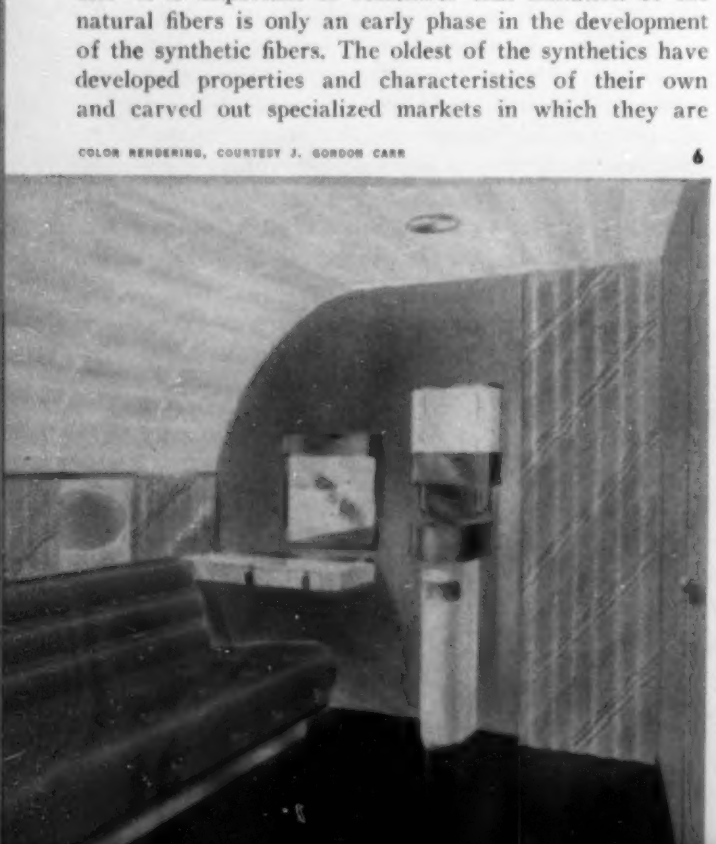

6—*Glass fabric wallcloth insulates and soundproofs a modern airliner.* 7—*Helicopters offer opportunities for plastic fabrics*

COLOR RENDERING, COURTESY RAYMOND LOEWY

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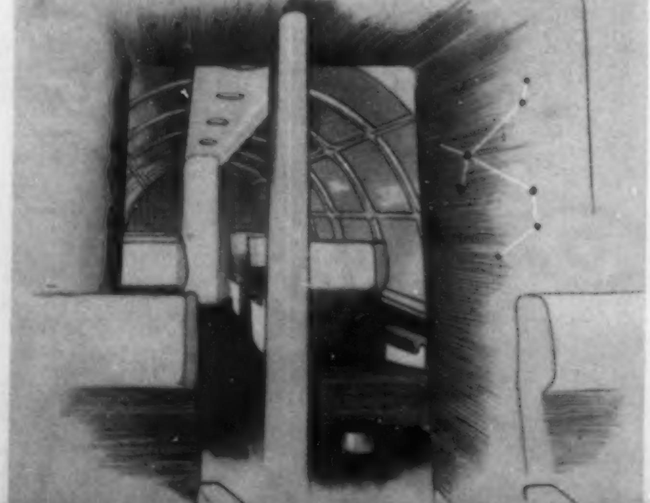


cellulose and one quarter acetyl. As might be expected, viscose, cuprammonium and nitrocellulose are similar in their properties while acetate differs markedly.

Comparatively few of us appreciate rayon, perhaps because it has developed before our eyes from a fiber of humble pretensions and uncertain propensities into a fiber of beauty and durability. In the fashion world it suffers still by comparison with silk, the traditional aristocrat among fibers, although some silk-type rayons today are indistinguishable from silk and many a lady who traditionally wears only silk is innocently gowned in rayon. Rayon has given the world silk-type fabrics within the reach of all, and since the war has made silk unavailable, it has filled the gap in the fashion world with admirably woven fabrics. Silk remains the more durable and aristocratic apparel fiber, but for sheer dramatic beauty and decorative effect in weaves like satin, rayon excels. Originally the most lustrous of all fibers, it is now produced in any degree of luster or dullness.

Rayon's principal weakness is its loss of wet strength, and its resultant laundering problem. Acetate, viscose and cuprammonium all share this weakness in degrees varying from 40 to 60 percent. Its strength is completely recovered when dry, however. Rayon is also, particularly in the acetate process, sensitive to heat (acetate distorts at relatively low temperatures), but this difficulty has been largely overcome by informative advertising. Compared with silk and nylon, its elasticity is poor, but it has a compensating ability to take a high twist. The high-tenacity rayons developed by recent research have less elasticity than regular-strength rayon, but again their ability to take a high twist is a compensating feature. Another early weakness of rayon was its lack of resilience which resulted in fabrics with no wrinkle resistance, but the introduction of a permanent crimp has improved wrinkle resistance.

The American rayon industry has grown from an experimental venture of 1910 to an industry of the first magnitude. Pivotal points in its career were the adoption of the name "rayon" in 1924 and the development of rayon staple fiber. The adoption of the name "rayon" established it as an independent fiber on its own merits, and improved consumer relations which had suffered from the variety of labels under which rayon was sold—labels varying from "silk" to "artificial silk" and "all silk."

Throughout the world of rayon, cut staple was the outstanding development of the thirties. In the making of rayon the solution which passes through the spinnerets emerges as a fine continuous strand called a filament, which is wound around a spool. Several filaments are usually twisted together to make one yarn, and the yarn subsequently woven or knitted into cloth. Fine filament, or so-called "multifilament" yarns, command price premiums as a rule. The manufacture of rayon staple consists of spinning continuous rayon filaments (*not* rayon yarns) and cutting them into uniform short lengths like those of the natural fibers which must then undergo a spinning operation by one of the natural fiber systems to become yarn. Rayon staple looks very much like cotton wool—a mass of cobwebby fibers—though it has a silky feel. Its ability to be spun on the cotton, woolen, worsted, linen or spun-silk systems enables it to simulate all of these fibers. Staple fiber is a true fiber since it must be spun before it is in yarn form, while continuous filament rayon yarns should properly be regarded as yarns and not fibers. Commercially, however, they are included in the fiber markets, although their price compares with the yarns of the other fibers rather than with the fibers themselves.

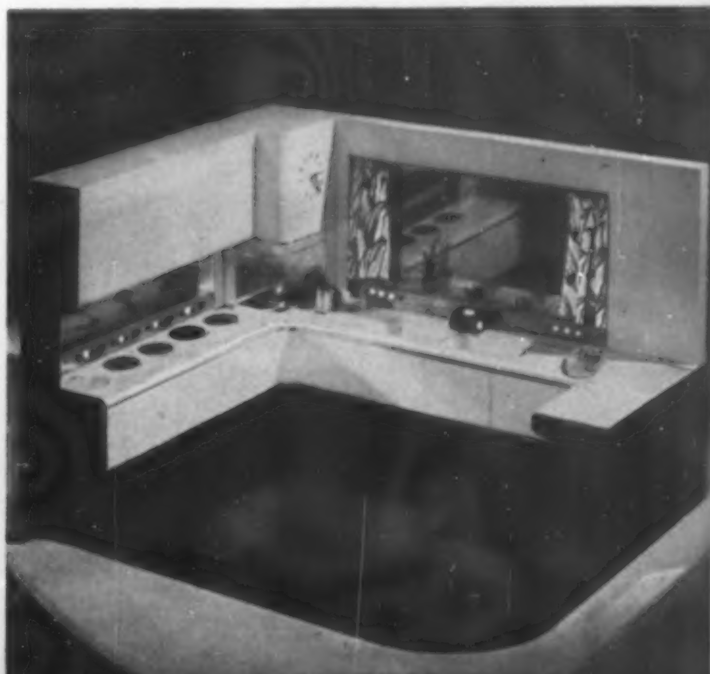
World rayon staple production increased from 6¼ million lb. in 1930 to an estimated 2,025 million lb. in 1942. Most rayon staple is made by the viscose method, although it can be made by the other processes. Its phenomenal rate of growth is due to its ability to simulate linen, wool and cotton, to its unique style qualities in weaves like shantung, gabardine and twill, and to its low price. In the Axis countries—Germany, Japan and Italy—its growth during the thirties was also due to economic nationalism and the effort to achieve self-sufficiency in textiles despite natural fiber shortages in these countries.

Many authorities predict that rayon staple will become one of the major fibers of the world. It is extensively used as a blending fiber. Distinction should here be drawn, perhaps, between *combining yarns* and *blending fibers*. Yarns are combined when one yarn is woven into the warp and a different yarn woven into the filling of a fabric; yarns are blended when two or more *fibers* (not yarns) in the form of cut lengths usually two to six inches long (called "staple fiber") are well mixed by a

8—New York subway car is upholstered in vinylidene chloride fabrics. 9—Gay plastic fabrics make practical kitchen curtains

8 KODACHROME, COURTESY FIRESTONE INDUSTRIAL PRODUCTS

9 KODACHROME, COURTESY BARNES AND REINECKE



picker and spun into yarn. So-called combination yarns are those in which two or more different yarns have been twisted into one.

The cotton industry is the chief market for rayon staple. Cotton absorbs the bulk of the rayon staple output for mixture fabrics and for all spun rayon fabrics. Before the war, Germany and Italy led the world in the development of new types of rayon staple such as tow-type staple and resin-impregnated spun rayons which will be increasingly important in the postwar era.

Rayon is an example of increased consumer demand with decreased prices. With its decrease in price over the years has gone an increase in quality and the development of special yarns such as the high-tenacity (or high tensile strength) yarns which gain added strength by a stretching process that orients the molecules. Before the war, the chief market for rayon yarn was in broad goods. Broad goods (or yard goods), used largely for apparel (underwear and outerwear) and also for decorative fabrics and tire cord, absorbed 77 percent of the rayon production in 1939. Knit goods, such as underwear, absorbed about 14 percent of the production, while hosiery used only 4 percent, and narrow goods such as braids, ribbons, etc., used 3 percent of the 1939 production; the remaining 2 percent was absorbed miscellaneously. By the end of 1942 hosiery's share had mounted to 11 percent.

High-tenacity viscose rayon had been adopted for use in tire cords and sails for boats and for certain apparel markets even before the war, though its tire cord possibilities were not highlighted until the Army chose rayon for heavy-duty tires. The Army's choice of high-tenacity rayon for heavy-duty tires marked a signal victory for rayon since tires were a well-established cotton market, absorbing 8 percent of the U. S. cotton production, or 389,500,000 lb. in 1941. In the same year, the total production of viscose rayon, the only kind used for tires, was 285,000,000 pounds. The tire market, then, would offer viscose a tremendous outlet in the postwar years, but undoubtedly cotton will fight for its tire market, and it is too early to say how much of it will become a rayon market. Nineteen forty-four production of rayon for tire cords is estimated at 150,000,000 to 175,000,000 pounds. Rayon appears to have given complete satisfaction for heavy-duty tires, although its adaptability for passenger car tires is still a moot point.

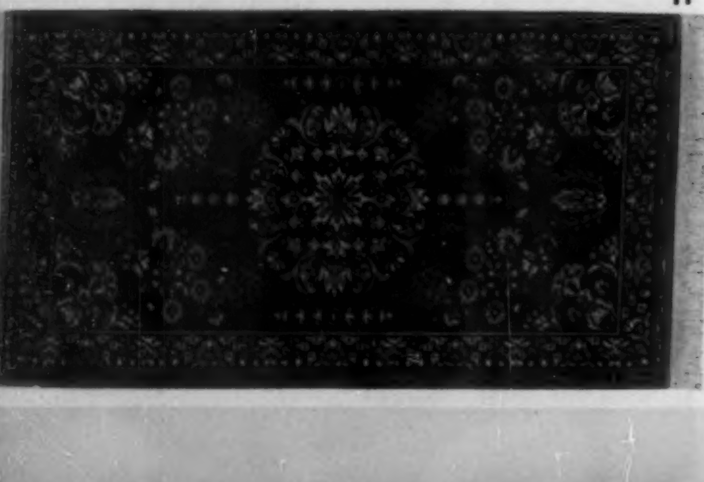
Rayon has gone to war, of course, like all of the synthetics, and continuous-filament high-tenacity viscose yarn appears in parachutes, shroud lines and military equipment. Perhaps its most strategic use is in parachutes; while the paratroopers themselves drop from nylon or silk parachutes (always white or camouflaged), blue, red, and yellow rayon chutes deliver ammunition, mortar, small field pieces and baskets of general supplies, carrying weights up to 150 pounds. The small fragmentation bomb chute is also rayon, but the 48-ft. cargo chute is all nylon construction supported by 1-in. flat tubular nylon webbing. The webbing of this great chute has a test of 3,000 lb., and the chute carries loads up to 10,000 pounds. An ultra-strong cellulosic yarn has been developed which is now being used for flare parachutes. It is a light-weight yarn and its great strength and dimensional stability will make it a probable contender in the postwar apparel market. A high impact acetate yarn recently developed has unusual extensibility, an essential

PHOTO AND COLOR PLATES, COURTESY CELANESE CELLULOID CORP.

10

10—*The lightness and delicacy of saponified acetate yarn belie its strength.* 11, 12—*Colorful rugs in Oriental designs are woven of acetate rayon yarn.* 13—*Waterproof, windproof, two-man nylon tents are used by mountain infantry in Alaska*

11



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in parachutes dropping loads of ammunition or cannon.

In the prewar women's hosiery market, rayon had lost ground proportionately to silk and nylon. Nylon is generally expected to capture the postwar hosiery market because of its greater elasticity and durability, and its quick-drying properties, but rayon and many of the newer synthetics will compete in this market. Rayon expects to compete with its high-tenacity yarns, both viscose and acetate, which are more durable and elastic than the rayon yarns formerly used.

Acetate rayon bases its postwar future on its cross dyeing properties and its thermoplastic and quick drying qualities. Its sensitivity to heat, once its greatest weakness, is in some markets an advantage, since acetate rayon fabrics may be welded instead of stitched together, and by this process acetate clothing is made without stitching. Acetate's thermoplastic quality lends itself well, too, to special finishes, such as moire, in which a permanent finish, never possible in silk, is molded into the fabric, and to embossed patterns and permanent pleats. Acetate satins achieve their delightful "hand" by reason of this same thermoplastic quality; they are put through calendering and embossing rolls and molded under heat. Acetate absorbs little water and dries almost as rapidly as nylon. This quick drying property has made it popular for suitings and bathing suits and will make high-tenacity acetate a strong contender in the hosiery market.

Among special rayon yarns may be mentioned Fiber D, a crimped rayon staple fiber sold only for spinning into carpet yarn, and the new Fiber G, a viscose process rayon yarn of super tenacity which does not lose strength when wet. Fiber G is still in the experimental stage, though it has been used in small volume in industrial fields such as tire cords. Its producers have issued no detailed information about it as yet, and little is known about it except its great strength.

Cuprammonium rayon has always been notable for its fine-filament yarn. Fine filaments are responsible for its silky appearance and "hand." While all of the rayons have improved so that it is now hard to distinguish silk-type rayons from pure silk, cuprammonium more generally resembles silk in all of its weaves than acetate or viscose and is notable for its luster and finish. Cuprammonium's war uses have been those of a more delicate fabric than its tougher relation viscose. They include flare chutes, ribbons, ties and banners. In the postwar markets, cuprammonium will probably be notable as it was in the past, for its sheer dress fabrics, its satin and moire upholstery materials that feel like silk.

Nylon

Nylon is a generic name for materials defined as "synthetic fiber-forming polymeric amides distinguished by a protein-like chemical structure." At present 10 types of nylon are fabricated, each with different properties. The physical and chemical properties of nylon fiber differ from those of any other man-made fiber. It is stronger, more elastic and more durable than silk, but less soft and absorbent. Although very tough, it is very fine.

Nylon is only a few years old, but shortly after its appearance in October 1939 it captured the hosiery market, which absorbed most of its production. At that time nylon production was not large enough to satisfy the demand, but the company has greatly increased its capacity during the war, and production is expected to reach 22 or 23 million lb. with the completion of its new plant. If used entirely in hosiery, this should account for about 60 percent of the U. S. hosiery market. The textile industry believes the demand is such that nylon's entire production will go into hosiery; however, the manufacturer expects that there will be yarn for the apparel market, for household textiles and other uses.

In common with most of the synthetics, nylon has one present limitation which is a potential advantage in hosiery. Because of its thermoplastic qualities it is permanently shaped by heat without using a seam. All acetate and nylon hose are in this way preformed or pre-boarded, but since the machinery of many mills is geared to the making of hose with seams and since women traditionally prefer hose with seams, nylon and acetate stockings are usually made with seams despite their already permanent shape. Manufacturers hope to overcome this consumer prejudice caused by the sagging and shapeless seamless hose of the past, and to introduce seamless hose in the postwar market. *(Please turn to page 184)*

 PHOTO, COURTESY TEXTRON, INC., DIORAMA BY LOUIS PAUL JONAS

Tips for the future

STRONG, streamlined, brightly colored and adaptable to modern design, plastic pencil ferrules are here to stay. "Definitely above the substitute class" because of appearance and performance, is the verdict of the American Lead Pencil Co., a firm which has been using the ferrules successfully for several years and which plans to recommend them to its postwar customers.

This manufacturer definitely feels that plastic, in the form of injection-molded, thin-walled (0.020 in.) thermoplastic ferrules, will not only meet the competition of the steel recently released for pencil tips, but will also hold its own against traditional copper alloy and other metals when they are available. The pencil company's angle is that its plastic ferrule, rigidly tested for performance, is superior to metal because of its lightness, flexibility, color appeal—in short, its modernistic trend—and because of the economies in material and manufacturing operations which it effects.

Equipped with its own molding plant, this company has been able to examine materials, molding and design extensively since it started to experiment with plastic ferrules in 1940. Trial molds were designed and redesigned. Many varieties of thermoplastic material in all degrees of hardness were tested under varying conditions before the present satisfactory compound, moldable in the required 0.020-in. section, strong, flexible and dimensionally stable, was developed. They have also been able to cure other early headaches by achieving in molding the proper weld for strength and by developing a precision de-gating fixture.

Cellulose acetate butyrate, because of its excellent dimensional stability, is to date the ideal material for this purpose. Other material, however, have proved to be satisfactory. It was found necessary to keep the plastic soft so that the ferrule could be anchored to the pencil by the prick-punching method used for metal tips. Another factor which was given much attention was the proper proportioning of regrind and virgin material in the molding compound. Discovery of the right combination of these two elements speeded up the molding cycle.

Molding

This painstaking experimentation has covered every phase of the manufacture of the ferrules from the conditioning of the material to the actual injection. It was realized that only an exceptionally thin-walled molding could properly be applied

KODACHROME, COURTESY TENNESSEE EASTMAN CORP.

1

to the pencil, especially with the machinery already in use for metal tips.

Because of this fact, extruded thermoplastic could not be employed since it was difficult to extrude sections having at the same time the required thinness, the necessary ±0.001-in. specification, and the perfectly round form which was needed. It was also found that the cost per pound of the extruded plastic was higher than that of the injected, and injection molding had other advantages.

It is the 0.020-in. section of this plastic ferrule which is the real molding achievement. The parts are made in 120-cavity molds set up to operate in the lowest possible time cycle. Difficulties with the molding were encountered, but the chief problems have been licked—the weld can now be controlled and absolute temperature control of the mold itself has been attained.

Another engineering feature of the utmost importance in this application is the high-speed precision de-gating fixture which quickly clips the ferrules so clean that the gate is all but unnoticeable. Pencil manufacturers must be very fussy about the cut of the ferrule for its appearance is of paramount importance.

Types of ferrules

Plastic ferrules, manufactured by this pencil company in two styles, can be attached to the pencil on the assembly line used for metal tips. The more primitive type employed for the cheaper grades is, save for the addition of color, a reproduction in plastic of the old metal part. It is a simple molded tube which is anchored to the pencil and to the eraser plug by the traditional prick-punching method. Only with exceptionally thin-walled, flexible plastics is this technique possible if standards of appearance are to be maintained. With thicker sections, the ferrule protrudes causing an unsightly overhang.

Especially designed to make the most of the good looks and color possibilities of the new material is the second, glue-anchored ferrule used on the quality product—the Venus and Velvet pencils. Two ribs, separated by $^3/_{32}$ in., are borders for a brand-identifying colored stripe lacquered on the ferrule after molding. No prick punching mars the glossy surface. With only a simple modification of the assembly line, it has been possible to fit the ferrule onto the end of the pencil and to anchor both eraser and ferrule by glue.

Save for the variation in the mold itself, both styles are similarly molded of the same materials, and the manufacturer has found that the performances of both are entirely acceptable.

Advantages of plastic tips

In addition to its unlimited color range and high-style potentialities (its major advantage if one does not consider the reduced hazard of plastic as compared with metal for the tip-chewing set), one of the chief arguments in favor of the plastic ferrule is the streamlining of the manufacturing cycle. Save for the lacquering of the stripe, the ferrule emerges from the mold ready for assembling, and many of the operations necessary in the fabrication of the metal part are eliminated. Even when the entire molding process is taken into consideration, it is simpler to fabricate and assemble the plastic than the metal ferrule.

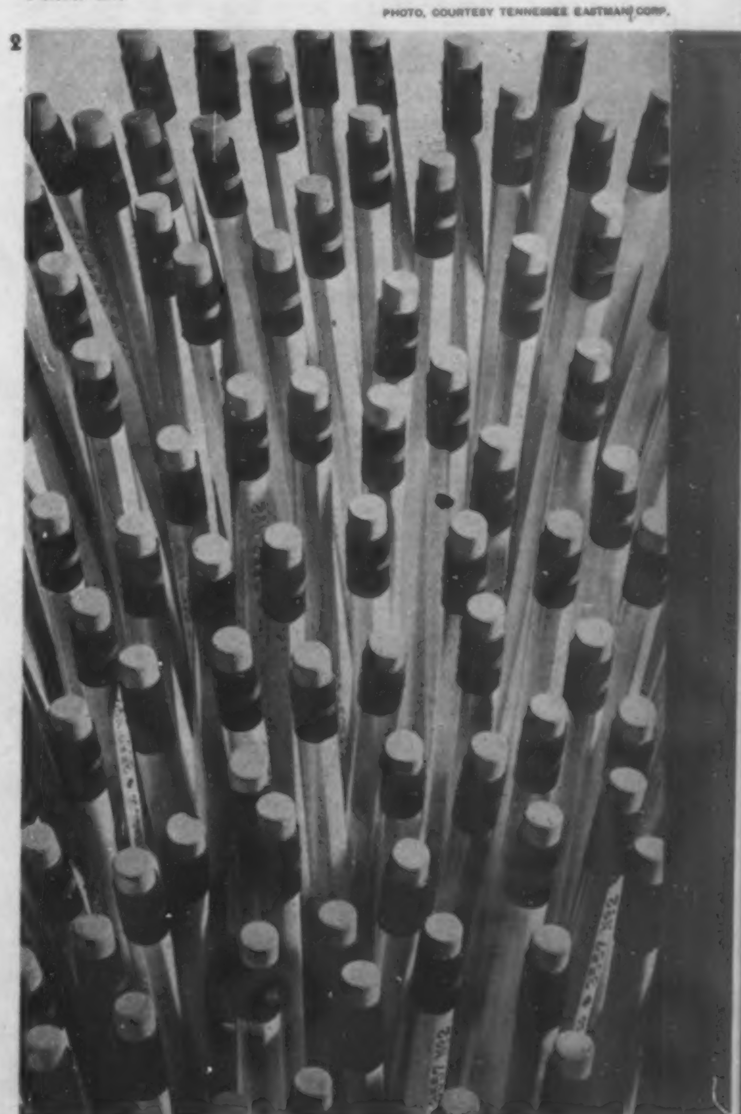
For our age, the lightness is an additional attraction, as is the elimination of waste material. The plastic raw material costs two or three times as much per pound as steel, twice as much as copper. Offsetting this, however, is the fact that the plastic yield is nearly four times greater than that of the average metal employed before the war, for the plastic part weighs only half as much as the metal and, in addition, about 50 percent of the alloy is wasted in the manufacture of metal ferrules and must be sold as scrap. The sprue, the only thermoplastic waste, is reground and used again in the molding compound in combination with virgin material.

For innate strength and strength of anchor, plastic ferrules have acquitted themselves well. If they are less strong than metal, they are nonetheless strong enough to behave admirably in use under a comprehensive range of conditions. At least one pencil manufacturer is convinced that their advantages more than compensate for their short-comings, that the plastic ferrule is no longer an experiment but has become an established and accepted factor in pencil manufacture.

Credits—Material: Tenite II. Molded by American Lead Pencil Co.

PHOTO, COURTESY TENNESSEE EASTMAN CORP.

2



1—Bright injection-molded plastic pencil ferrules come 120 to the sprue and can be made in a variety of colors. The perfection of a molding with a thin 0.020-in. section made it possible to anchor these tips satisfactorily with the standard pencil-assembling machines. 2—Tips for the quality grades make the most of the good looks of the plastic. An identifying band gives effective color contrast, and the ferrules are anchored to the pencil by glue

Molding via grease gun

REPORTS coming from England tell of a comparatively new polyvinyl chloride paste which can be molded by ejection from an ordinary grease gun into any metal mold to which heat is applied by a Bunsen burner, blow torch, oven or almost any other heating medium. The polyvinyl chloride pastes are particularly useful for joining cable that is covered with polyvinyl chloride. This is accomplished by fusing the cable and paste in a form at temperatures of 300 to 350° F. without the application of any pressure. Dipped gloves have been made by immersing porcelain forms in polyvinyl chloride paste dispersions, withdrawing and draining. Several coats may be built up by applying slight heat after each immersion, followed by a high-temperature heat after the last dipping. It is obvious that many other articles could be manufactured by the same process.

This paste is a dispersion or emulsion of polymerized polyvinyl chloride resin in a solvent plasticizer or mixture of solvent plasticizers. This dispersion, which consists of from 40 to 60 percent of solvent plasticizer, can be spread, coated, squirted under low pressure into molds, or used as a dipping solution. The dispersion is "gelled" into a "cheesy mass" by heating at a temperature of between 200 to 212° F. On subsequent heating at a temperature of 300 to 350° F., it fuses into a homogeneous, tough, elastic film or molding.

In order to get a stable dispersion, the resin must be of the proper particle size prior to mixing with the solvent plasticizer or plasticizers. The emulsion polymer made in England is a very fine eggshell variety which can be easily cracked on grinders into small particles of proper size. Ball milling has been tried with only partial success and only when the temperature of the mill is kept low.

All spread-coating of polyvinyl chloride in the United Kingdom is done by the paste method. In the preparation of this paste, pigments, dyes and fillers may be added, to the extent of 33 percent of the final coating, by grinding and dispersing the fillers and the plasticizer-mix prior to the addition of the resin. No special care is needed in mixing the resin and plasticizer, with or without pigment, on ordinary nitrocellulose stirring equipment. Solvent plasticizers should always be used to manufacture the paste. However, these plasticizers may be extended with various materials such as chlorinated paraffins and other slightly solvent or non-solvent materials.

The pastes are spread on cloth with an ordinary doctor-knife spreader equipment and steam-heated beds such as are used in rubber spreading. A solvent recovery system is not necessary because no solvent is employed. If an unusually thin coat is desired, a small portion of a diluent such as a non-aromatic paraffin hydrocarbon is used. The coating, on passage over the steam bed, is heated to approximately 200 to 212° F. and gelled. Immediately thereafter another coat may be spread, and it in turn is gelled. This process may be continued for any numbers of layers. The coating is then fused by passage under radiant-strip heaters or infrared bulbs, or by baking in an oven at a temperature of 300 to 350° F. Adhesion may be improved by heating from the back of the cloth. The resultant coating is tough, elastic and quite flexible. One of the chief advantages in spreading polyvinyl chloride paste is the large quantity of coating which may be laid down in one application. Claims have been made that, on experimental equipment as much as 1 lb. per sq. yd. of coating has been applied with one pass. Normally, three spreadings of polyvinyl chloride paste are equivalent to eight to ten spreadings of solutions of polyvinyl chloride.

There seem to be few insurmountable difficulties in the way of the adaptation of this vinyl paste to industry in this country, but there are limitations that must be considered. Certain requirements, such as the use of 40 to 60 percent plasticizers, which make the material elastomeric, must be met in order to obtain satisfactory results. Furthermore, extreme care must be taken in choosing plasticizers so as to prevent a tendency to sweat. This polyvinyl chloride paste tends to "liver" or gell on standing. If it does not reach an advanced stage, a diluent can be added and the paste will be usable. However, the solids content will be reduced by the amount of diluent that is added.

Another limitation is the lack of adequate molding or forming equipment to handle this particular type of plastic which demands that great care be taken, because of the low pressure involved in molding or coating, to see that no air is entrapped. In order to handle this material in great quantity, molders would have to start thinking in terms of a larger number of molds operating at a low production rate. This is in contrast to the current practice of using large or multiple-cavity molds at a high production rate.

The big advantage in using vinyl paste is that the item to be molded is formed in place without internal stress or strain. The viscosity of the material is not dependent upon molecular weight and does not require the excessive pressure or expensive solvents normally required. All present developments are, on the whole, more competitive with rubber-like materials than with most other thermoplastics. This is attributable to the high percentage of plasticizer which results in a highly elastomeric material.

The dispersion principle is a radical change from any molding process used heretofore in this country, and it opens a wide field for new development. By the dispersion principle, raw material is mechanically dispersed in a liquid plasticizer mixture which, after spreading or insertion into mold or form, gells on heating at about 200° F. On further heating to 310 to 325° F., it fuses into a characteristic tough, horny vinyl film or molding. This principle differs from ordinary techniques, such as colloiding on rolls or depositing from a solution, in that the resin and plasticizer are not intimately colloided until the paste is heated in place at the fusion temperature. The resin particles are not greatly affected by the plasticizer until the plasticizer itself is made more solvent by heating to a temperature of approximately 200° F.

In ordinary technique the resin and plasticizer are intimately colloided in heated mixes and further mixed on hot rolls or extrusion equipment. The resulting molding material or strip is then shipped to the fabricator who must reheat it to a high temperature in order to mold or extrude a finished product. In the dispersion process all materials are mixed and flowed into place while cold. They are then heated to fusion temperature and cooled for the final product. This method eliminates many intermediate steps including the use of high pressure.

It would be comparatively easy for a garage mechanic to adapt this principle by using (*Please turn to page 178*)

1—The all-plastic cockpit light at the right is permanently fastened at a strategic point in the plane where pilot and co-pilot can use its controlled rays to the best advantage. The front of the lamp can be shielded with a red filter mounted in a removable frame. This red light protects the eyes of the fliers from the glare of the lamp which might cause night blindness

1

PHOTO, COURTESY LIGHTS, INC.

Lights that talk

by E. F. LOUGEE*

LIGHTS are vital to military personnel. A brief flash speaks volumes to those within vision. Yet there is no warning sound for the enemy to hear, no radio waves they can trace. Lights whisper orders from pilot to bombardier, faster than words. They silently bark commands for split-second action. They must always work. They must never fail. Modern warfare, especially aerial pin-point bombing, depends for its success upon meticulous team-work of the bombing crew. And this team-work goes beyond human training and efficiency to include every working part of the ship, its fighting equipment and its signaling devices. It goes even farther to embrace the coordinated action and precise timing of every bomber and escorting ship in the sortie.

Color is of almost equal importance. Through color, signals are given expanded meaning and larger vocabulary, even for a single flash. The color may be red, green, white or blue; or a combination of these colors speaking together for more definite instruction or identification. Or, one color may be flashed after another to explain circumstances or conditions vital to the crew and its mission. Color must be clearly defined and permanent so that there will be no confusion.

It isn't surprising then to learn that as war has progressed, many changes have been made in signaling lights for aircraft, and that many of these changes involve plastics of one kind or another. This has been a problem to the molder because quantities are comparatively small and designs have been switched suddenly from time to time. They are being switched again right now. It often happens that before the die maker can more than peel off the first two or three layers of steel in his planer or drill, the first positioning holes in his block of metal, the design is changed or cancelled outright. It is possible that even now the lights described in this article are obsolete. However, this is of no great consequence so far as this story is concerned, since changes are dictated by experience in battle and each change marks a step forward in the efficient operation of aircraft on the fighting fronts. It is almost certain that whatever changes take place, plastics will be used because of their good insulation properties. A complete molded plastics fixture in which metal is used only for conductors and connectors, seldom short-circuits or gives trouble unless it breaks. And once in service, breaks are rare.

Military aircraft require many lights. They identify the ship to ground crews and to other fliers. They indicate the plane's rapidly changing path in maneuvers. Other lights flash messages from ship to ship, and from ship to ground. However, the majority of lights in a single airplane are known as indicator lights. Their purpose is to keep pilot and crew informed of any change in the operating efficiency of their ship, just as the warning light on the instrument panel of your automobile tells you when your oil stops pumping or your generator fails to charge. If one engine gets too hot, the pilot is warned instantly so that he can circulate cold air around the hot-air jacket. If his landing gear jams, a light tells him so.

In some ships, the bombardier may have a whole panel of indicator lights before him—like a small telephone switchboard. There is a light which marks the position of each bomb in his rack, lights to receive direct orders from pilot or co-pilot, and lights of various colors for many other things. For instance, a bomb-indicating light may switch from amber to green as the bomb is released from its rack. If a salvo is released, a group of lights indicate whether or not bombs have successfully left the ship. If a bomb hangs up in the rack, the light may flash red to warn the bombardier that he has a "hangover" on his hands. Other lights tell him when the bomb-bay doors are opened and when they are closed.

Similar indicator lights are used all over the ship. Each has its definite duty to perform, and each forms a link in the perfect chain of inter-communication devices that gear every act, every thought, of the crew in perfect coordination. (Ed.: Any mention of colors and their sequence in signaling which may coincide with actual conditions is purely coincidental. Colors have only been mentioned to indicate their function and to establish the important contribution plastics made to this intricate signaling system.) *(Please turn to next page)*

* Plastics Institute.

PHOTOS 2 AND 5, COURTESY LIGHTS, INC.

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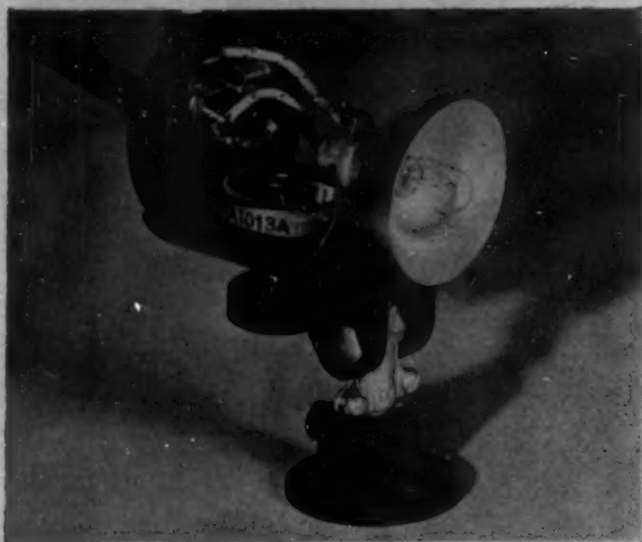

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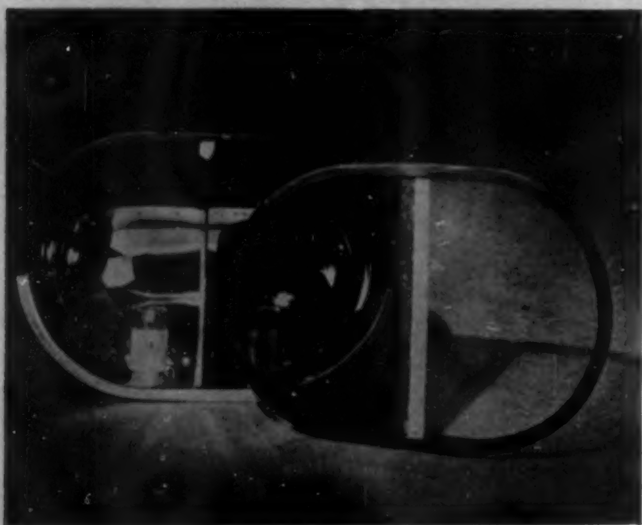

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Engineers at a plant in California who have made some 300,000 indicator lights report a tendency toward standardization in plastics materials for this application, even to lenses. Originally, the lamps were made of aluminum which had to be shielded with a laminated phenolic tubing inside. This complicated the manufacturing procedure since the plastic tube had to be cemented to the aluminum housing, and cements are seldom compatible to both materials and hence often let go. The difference in thermal behavior of the two materials further complicates their function. It would seem that once approval has been obtained and, if possible, a definite design decided upon, plastics will improve the stability and performance of these indicator lights and lower their cost. There is a definite trend afoot to standardize all aircraft signal lights. If this can be accomplished within the scope of ever-changing combat conditions, many of the present molding difficulties will disappear.

Two of these indicator lights are pictured in Fig. 5. The model at the left is aluminum, the one at the right is plastic. It will be noted that the flange at the top of the phenolic tube is slightly thicker than that on the aluminum lamp. In the first change-over to plastics it was necessary to make the flange somewhat heavier to prevent breakage when some over-enthusiastic mechanic applied his screwdriver in assembly. This difference is being overcome by redesign. The new model will be flush with the mounting, and the flange may not appear at all when more suitable fastenings have been developed. In spite of the heavy mold cost resulting from short runs and changed design, the plastics unit is less costly to make because no shielding is required inside and no finishing operations or painting are necessary. The present saving is about 8 cents per unit. Once standardization is achieved, the repair and replacement problem, especially important overseas, will be greatly facilitated and a more dependable lamp fixture will result.

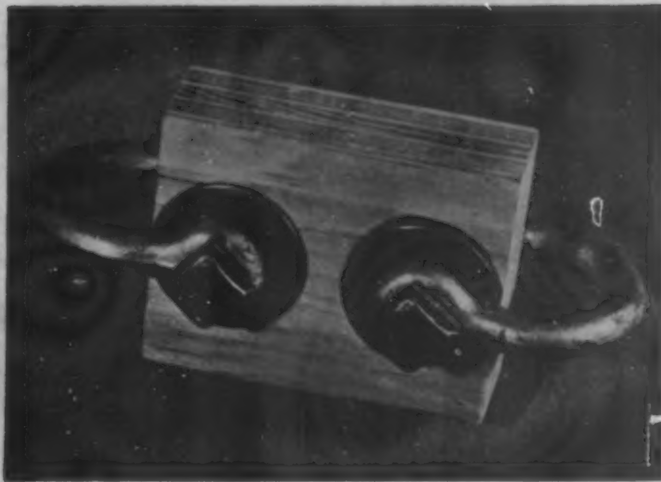
The new all-plastic cockpit light (Fig. 1) is a spotlight de luxe, permanently fastened at a strategic point in the cockpit where pilot and co-pilot can use its controlled rays for map reading, trouble shooting or for other purposes. It is also used by the navigator and other crew members who need controlled light of this sort in sharply defined areas. The weight of the complete unit is 12 oz.; its approximate size 4 × 4 × 5 in. The spot can be focused by sliding the inner carriage forward or backward, and it is held in position by a knurled tension knob big enough to handle comfortably with gloved hands. Beneath the tubular body there is a rheostat which controls light volume from zero to bright. At the rear of the housing there is a little white button for signaling, or for an instant flash of light on a map. The front of the lamp can be shielded with red filter glass mounted in a removable frame.

The red filter is of utmost importance. Fliers are conditioned for night flying by remaining in a darkened room where the only illumination is a (*Please turn to page 184*)

2—All four molded parts that are included in the cockpit light assembly are transfer molded of medium-impact cotton-filled material. 3—The base and back of the cockpit lamp are molded in one piece—forming an L shape for the insertion of wires and electrical connections. 4—Now awaiting official approval is the 2-color plastics lens for a bomb release signal lamp. 5—Indicator lights are an important part of aircraft equipment. Aluminum model (left) was replaced by the plastics unit (right)

PHOTOS, COURTESY CORDO CHEMICAL CORP.

1



2

1—*Formerly, a bolt could be pulled from a section of plywood, 1⅜ in. thick, by the exertion of a 1400 lb. pull.*
2—*Now, by means of a plastic-base adhesive which bonds together such unlike materials as metal and wood, iron washers can be bonded to both sides of the plywood, reinforcing the structure to withstand a pull of 4000 pounds*

Bonding metal to wood

by CORYDON M. GRAFTON*

FASTENING together dissimilar materials such as metal and wood has long been a major assembly problem in fabrication and production. Various mechanical means have been devised and used for generations. The first undoubtedly consisted of tieing parts together with thongs; then, metal pegs or crude metal nails were used. Still later, screws and bolts of many types were invented which accelerated mechanical operations and provided greater strength. Until recently, the best bonding methods were mechanical.

In the past few years, chemical means of bonding metal to wood have been conceived. Initial developments required the introduction of high temperature and pressure to attain high-bond strength. This method has definite limitations, the most serious being the difference, under heat, in the coefficients of expansion of metals and wood. This is particularly true in laminating large areas. The contraction on cooling, after the bond is made, causes stresses in the glue line that disrupt the bond, or severe warpage of the laminated materials.

A new series of adhesives affords maximum bond between metal and wood without the necessity of baking at elevated temperatures. A plastic base adhesive, Cordo-Bond[1] No. 250 A, is applied as a priming coat to the metal and baked for 15 min. at 250 to 300° F. This provides exceptional adhesion to practically every type of metal, including brass, stainless steel, aluminum, iron, steel, copper, lead and tin. A low-temperature thermosetting resin, Cordo-Bond No. 200 P, is then applied as a combiner to the primed metal and to the wood. The bonding is accomplished at room temperature.

Any type of wood may be used with the primed metal. The resulting bond strength is such that a high percentage of wood failure occurs in shear tests. Laboratory tests with metal and hardwood have indicated over 1000 p.s.i. shear strength, with wood failure in the bonded area in excess of 50 percent. Laboratory data on typical bonds are presented in Tables I and II. Alternate immersion in water for 16 hr. of aluminum bonded to birch plywood, followed by 8 hr. drying at 170° F. for 10 complete cycles, gave no evidence of bond failure; but the plywood was badly cracked.

The primer is not completely thermosetting although the baking cycle materially raises the softening temperature. The combiner, however, is completely thermosetting. The strength of the composite bond is somewhat reduced at elevated temperature due to the semi-thermoplastic nature of the primer. Table III illustrates the effect of increasing temperature on shear strength of aluminum bonded to oak.

The primer may be applied by brushing, roller-coating or spraying to a metal which has been thoroughly cleaned by any accepted practice. For maximum results, the primer should be applied in a total dry thickness of at least 0.001 in.; heavier priming increases adhesion. The applied adhesive must be free of solvent before maximum baking. This may be accomplished by drying at room temperature for one hour or by baking at 200° F. for 15 minutes. For maximum adhesion the final bake should be at 300° F. for 15 minutes.

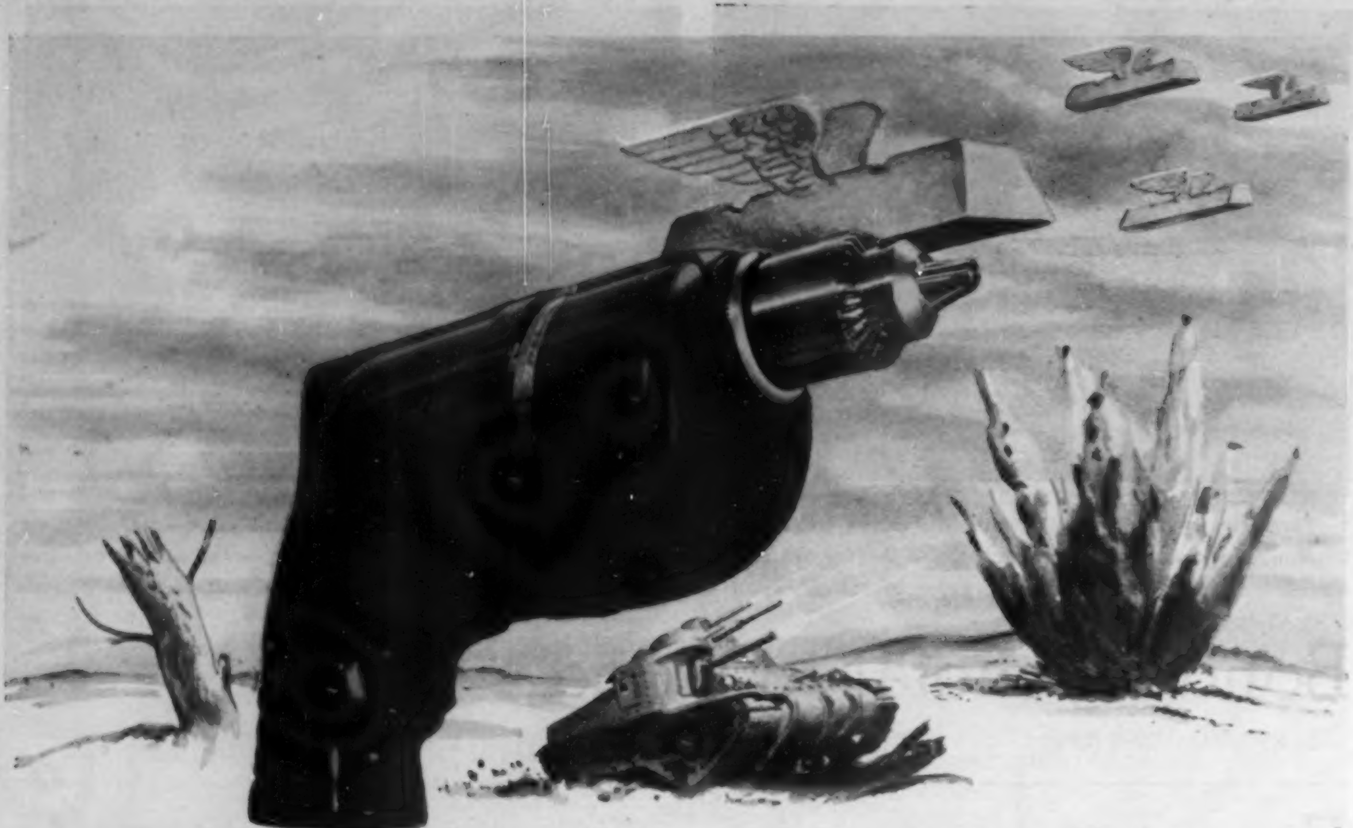
The combiner is supplied in two components: a liquid resin and catalyst. The working life of the mixed solution is 2 to 4 hr. at room temperature, after which time the solution thickens and becomes unusable. Storage at refrigeration temperatures, after mixing, will prolong the working.

The combiner is most effective if applied to both the wood and the primed-metal surfaces. (*Please turn to page 194*)

TABLE I.—DRY SHEAR STRENGTH OF CORDO-BOND

Metal	*Wood*	*Shear strength*	*Wood failure*
		p.s.i.	*percent*
Steel	Birch plywood	700	100
Aluminum	Birch plywood	700	100
Iron	Mahogany	800	100
Steel	Oak	1800	60
Stainless steel	Oak	1300	80
Steel	Maple	1000	75
Aluminum	Maple	1100	80

* Director of research, Cordo Chemical Corp.
[1] Trade name, Cordo Chemical Corp.



1

ALL COLOR RENDERINGS, COURTESY INDEPENDENT PNEUMATIC TOOL CO.

A hand drill goes to market

"IT'S a beautiful drill—light, more easily handled than we ever thought possible. It's well made, efficiently operated, powerful, simple to service, economical.

"But will it stand up? Will it take the hard knocks of everyday usage in the shop? Is it safe?"

This is what a large segment of industry wondered recently when one of the country's leading makers of portable electric and pneumatic power tools introduced a new product, truly revolutionary in its field—a heavy-duty hand drill housed in plastic.

It was not so surprising that these questions should be asked. The new drill is a $^1/_4$-in. type designed for all kinds of production operations. Every preceding model had been of metal—heavy metal in some cases. The industries in which drills like these are used are, for the most part, accustomed to working metals with tools made of metal, whether they are large or small, manual or automatic, hand-operated or stationary. And the distributors and dealers who handle this equipment likewise are accustomed to metal—to the point where any other material has only to be suggested to become an object of quick suspicion.

There was no question in the mind of the manufacturer that the new product was "right." He knew that it was backed by one of the most strenuous periods of testing any power tool had ever encountered; he was sure it would do anything its all-metal predecessor had done—and a whole lot more. Success on the industrial market seemed to hinge entirely on overcoming the doubt that existed in the minds of users and distributors with respect to the use of a material other than metal in a power tool which must withstand the most rugged operating conditions.

How this is being accomplished forms an interesting page in the record of plastics merchandising and reveals the possibilities of presenting the features of a new plastic product in combination with numerous highlights in the history of plastics development in a manner that is at the same time both dramatic and effective.

Two years or more ago, the Independent Pneumatic Tool Co. designed and first produced the new drill with its plastic housing. It was a broad departure and one brought about primarily by the threatened shortage of aluminum. Initial production went to the U. S. Army Air Corps which used the drills all over the world and found them particularly desirable in many respects—even more desirable than aluminum in some. In cold climates, the aluminum-housed drills stuck to the hands of the operators. In warm weather, they became so hot from the heat generated by the motor that they were difficult to use. The plastic drill did neither.

Then, a year ago, the company stepped up production of the drills for use exclusively in war industries.[1] Just a few months ago, the original drill, Model U14K, was put on the open market together with two companion models. All three drills are the same in capacity, size and weight, but with differing speed ranges.

Simultaneously with this introduction, the manufacturer started his merchandising effort, based solely on the plastic-housed product and planned solely for the purpose of "selling"

[1] "A handful of power," MODERN PLASTICS *20*, 55 (July 1943).

the new plastic application to his distributors, dealers, customers and prospects. Basis of the campaign is a comprehensive brochure, attractively lithographed in color and containing 20 pages, $8^1/_4 \times 11$ in. in size. Initial distribution was 65,000 copies, which went to all of the company's sales outlets and customers as well as to prospective users. Each of 1100 distributors was offered a limited quantity of the booklets for his own use, and so far more than 25,000 additional copies have been sent them. Thus, of the total print order of 100,000, more than 90,000 have gone out.

Backing up this distribution, Independent is devoting a substantial portion of its advertising in business, industrial and trade publications to this booklet and to the new tool which it describes. Altogether, more than 50 magazines are used in this program.

Although no direct attempt was made in the brochure to obtain inquiries, several thousand cards already have been received asking for more information about the drill and other tools manufactured by the company. Favorable comment has been widespread. Results have exceeded expectations and company officials believe they have achieved the goal toward which the campaign was directed.

"Frankly, our basic reason for preparation and distribution of this booklet was to present specific facts on the advantages of this new tool which, because of its revolutionary application of plastics, met upon its introduction with some scepticism as to its ability to stand up in everyday usage," said C. N. Kirchner, sales promotion manager of the company, whose department prepared the booklet in its entirety "We feel that the factual data in the booklet convincingly answers any question that may arise with respect to the tool's stamina."

In planning the booklet, Mr. Kirchner and his associates took full advantage of the fact that the exigencies of war speeded the development of the new tool, and that this need produced a plastic product that did a better job than the aluminum previously used. "Tools to Build the World of Tomorrow. . . . Born from the Need of Today"—such was their choice for the title.

The booklet starts its story with a short early history of plastics development, beginning with the "happy accident" which occurred when John Wesley Hyatt, an Albany printer, sought to create a substitute for costly ivory billiard balls and developed celluloid, only to find that a celluloid billiard ball is likely to explode under impact. Despite the failure of celluloid to serve the original purpose, Hyatt kept at his work with the material and later found it useful in making plates for false teeth and in the production of continuous film for photography. The "happy accident" of the exploding billiard ball (see Fig. 2) is drawn to show a world exploding with a multitude of new plastic products.

"As late as 1940," the booklet continues, "plastics still

2

1—Ingots of aluminum released by the drill's plastic housing take wings and fly off in planes of war. 2—Hyatt's billiard ball, exploding, releases a new world of plastic products

3—A girl's face, a rose's petals, a skimming sailboat, suggest the beauty, smoothness and light weight of the drill's new plastic housing

occupied an anomalous position as 'materials for gadgets'—tumblers and toothbrush handles, doorknobs and penholders, camera cases, spectacle frames, coffee-pot handles."

Then, the discovery of plastics "with the transparency of crystal, the thinness of tissue, the fineness of silk and the elasticity of rubber . . . plastics with the tensile strength of steel that outwear steel and weigh less than aluminum . . . . plastics that tinkle like glass and plastics tough enough to stop bullets" is outlined, bringing forth the conclusion that: "Thus having demonstrated their ruggedness, versatility and 'workability,' plastics have emerged as a dominant material in their own right . . . giving real credence to the promise that tomorrow will be the 'Age of Plastics.' "

After further reference to the origin and development of plastics, including the work of Dr. Leo Baekeland with his Bakelite, the booklet points out that since 1920 there has been a procession of new plastics at the rate of about one completely new material per year. As a result, industry today may select from any of more than twenty basic types of plastics, each possessing its own distinctive, man-endowed characteristics.

Proceeding to a discussion of the use of plastics in power tools, the booklet reports how Thor engineers ("Thor" is the trade name of Independent products) worked out the new plastic-housed drill in just 145 days as an emergency aluminum-conservation measure, at the same time "convincingly demonstrating that the replacement of aluminum with plastic housings in certain types of tools not only saves thousands of pounds of metals but definitely increases the efficiency of the tool and the productivity of the worker."

At this point, the booklet refers to the new tools as being "armored-in-plastic," a term carried through the remainder of the pages and through all of the company's other advertising as descriptive of the lightness, high-impact strength, low thermal conductivity, increased safety factors, and unusual toughness and durability of the plastic housing.

In this connection it is noteworthy that engineers of the company worked in close cooperation with the Tennessee-Eastman Corp. in testing 16 different types of plastic before finding the one that was satisfactory for the housing. The material is a cellulose acetate butyrate formula, and the company calls it Thorite.

Stress is laid on a reduction of 14 percent in weight as compared with aluminum, and a thermal conductivity of only 1.7 Btu. per hr. per sq. ft. per ° F. per inch. These two properties give a tool that is easy to handle and cool-running at all times. Figures for impact and dielectric strength are given as proof of the ability of the tool to "take it" under rough usage. They also indicate the protection against electrical shock the tools afford the workers.

After outlining the laboratory background of Thorite, the booklet goes on to tell the "human reasons" for the superiority of the new products. Here, the "kind feel" of plastics is described; because the tool feels comfortable in the operator's hand "the incidence of fatigue is so retarded that the individual's production is sustained on a higher level for a more prolonged period of each working day."

Particular attention is directed to a comparison of the new tool with a drill of comparable capacity cataloged at the outbreak of the war and now obsolete, having been succeeded by the aluminum model. It is shown that the new drill weighs only $3^1/_4$ lb. as against 8 lb. for the obsolete model, measures only $8^3/_8$ in. as against 13 inches. Thus in less than half the weight and almost half the space, the plastic-encased power tool gives equal drilling power and capacity.

The booklet concludes with a comprehensive outline of the new product's specifications and construction features, exceeding in power any electric tools of comparable size, weight and capacity that have as yet come from the company's laboratories.

Partly because of the exceptional performance of the U14K and associated models, and partly because of their acceptance and the success of the current merchandising campaign, the Independent company has announced that eventually it will have a complete line of "armored-in-plastic" tools. According to Mr. Kirchner, a number of other tools now are in the experimental stage or in the process of laboratory development. It is expected that some of these tools will be sufficiently advanced by the end of the year to permit of their announcement at that time.

Checking the angles

ONE of the most important tools of the ground crew of any plane, large or small, is the propeller protractor. Designed to determine, while a plane is on the ground, the angle of pitch of the propeller and to synchronize this angle on all the propellers of a multi-engined plane, the instrument is also used for various other purposes. These include checking plane elevators and all other parts where the exact relation of the angle of one part to the angle of another or to the ground, level or sloping, must be known.

Originally, propeller protractors were made entirely of aluminum, but early in the war it was feared that a scarcity of this metal might hamper production. Since the devices are so essential that at least one is needed for every ground crew, development work was begun, two years ago, on a plastic protractor (Fig. 2). Now, all the initial difficulties encountered in the intricate molding and assembly operations have been overcome and the unit is being supplied in quantity to the Army Air Force.

In design, size and general construction, the plastic protractor is practically a replica of the aluminum device. It is 7 in. wide and a little more than 7 in. high with a $4^1/_2$ in. handle on the back. Altogether there are 8 component parts (Fig. 1) which are molded of high acetyl acetate: the base, 2-piece finely calibrated dial, front dust protector, handle, front indicating level, and two small brackets.

Probably the greatest advantage of the plastic protractor as compared with the aluminum product is the accuracy of the calibrations and the thinness of the calibrating lines. Dial dies having the utmost precision are responsible for this accuracy and make possible the production of many dials possessing the same exactness of calibration. In contrast, each aluminum dial had to be individually engraved.

The dial pieces on the plastic protractor are fitted with greater precision than on the aluminum models. Specifications for both the plastic and aluminum instruments allow a "play" of only 5 min. in one degree. While the play in most metal protractors is about at this limit, in the plastic devices, it is, on the average, much less. The plastic dials have also made possible a considerable saving in man-hours of labor.

The squared edges on the bottom and sides of the plastic protractor are of phosphor bronze, much narrower than on the aluminum model where the edges are of aluminum. The bronze reinforcements are said to withstand rougher usage without getting out of alignment or sustaining other damage which would interfere with the operation of the instrument. After molding, the plastic parts (*Please turn to page 174*)

1

1—Eight parts are molded of high acetyl acetate.
2—Propeller protractors determine the angle of pitch of a propeller and synchronize this angle on all blades

2

Sheep in Mink's Clothing

1

A BEAVER coat for the price of sheepskin. Lynx for the cost of lambswool. Such are the prospects held forth by a new process developed by Dr. Jose B. Calva, Mexican-born scientist, at his laboratory in Minneapolis. By chemically reacting groups already present in the fibers of sheepskin and lambswool with a reagent to form a thermosetting resin, Dr. Calva has been able to simulate luxury furs so skillfully that it would require a connoisseur to detect the difference. Variation of the reagents have produced such effects as luster, curl, water repellence, wear resistance, mothproofing and increase in the diameter of the filament. Even the luxury furs themselves have not been overlooked in this process which, without changing or destroying the natural beauty of the furs themselves, can add permanent luster, crease resistance and wear resistance to rare and fragile skins.

Furs, however, represent only one application of the process which includes the treatment of jute, cloth, felt, pile, carpeting and bristles to effect crease resistance, body, silkiness, non-shrinkability, or whatever qualities the individual material requires to prolong its life or increase its usefulness.

The idea of imparting qualities other than those inherent in the fibers is not new. For some time there have been numerous processes in widespread use for the waterproofing and fireproofing of cloth. As early as 1929 we find a method of inducing crease resistance in fabrics. This process, which most closely resembles the Calva method, was invented by three Englishmen—Foulds, Marsh and Wood—and is known as the

2

1—This modish "beaver" started life as a sheepskin. It is one of the few available civilian offspring of the method. 2—An unprocessed pelt set between two processed skins points up the full effect of the Calva process on the tanned shearlings

Tootal Broadhurst method. It consisted of the condensation or polymerization of a synthetic resin—phenol-formaldehyde or urea-formaldehyde—in the presence of cellulosic fibers to produce crease resistance in materials without affecting the original suppleness of the fibers. Of more recent date we find other developments in the treatment of wool materials to eliminate shrinking and to improve wearing qualities.

The particular merit of the Calva method lies in the fact that it can be so applied that it merely encases the fibers, as do many of the other processes, to add certain properties without changing the nature of the material or, as in the case of sheep pelts, it can radically alter the nature of the fiber. The characteristic feature of the process is that in order to carry out these reactions, it utilizes the parent substance of the fiber itself.

Because of wartime restrictions, industrial utilization of the Calva method is limited to a single commodity—furs. Fifteen hundred skins a day are processed by the Winslow Bros. and Smith Co., shearling division of Armour and Co., and by Master Industries for the Army Air Corps and the Marine forces. Since they are the only visible evidence of the success of the process, an analysis of their preparation will serve best to illustrate the important features of the immersion method which is applicable to sheepskins or shearlings.

Tanned shearlings, selected for uniform quality, are first degreased and dried. Then they are soaked in water which swells the tanned leather of the pelt and serves as a means of drawing a properly selected substance—in this case a water solution of corn syrup—into the leather to protect it from contact with subsequent reagents and thus prevent deleterious effects. After this treatment, the pelts are again dried.

A solution is then prepared composed of 60 parts by weight of commercial cresol and 40 parts of a mixture of benzol, alcohol and water, hydrogen chloride being bubbled into the mixture to assure proper acidity and to act as a catalyst and dehydrating agent. The sheep pelts are submerged in it for 120 min. at 38° C., the skins being moved back and forth to insure uniform penetration. At the end of the time period, they are removed from the bath and the excess of treating fluid is removed mechanically.

Following this step, the skins are submerged for 20 min. at 45° C. in a solution of commercial formaldehyde having a concentration of about 40 percent by volume. The amino groups present in the pelt, which have been rendered active by the hydrochloric acid, react with the formaldehyde to give rise to condensation products. The formaldehyde also reacts with the excess of cresol.

The skins are removed from this bath and submitted to a series of washings: first, in running cold water to remove as much of the formaldehyde as possible; then, in a solution containing common salt and sodium bicarbonate. The salt is applied to prevent swelling which would annul the effects of tanning, and sodium bicarbonate to neutralize the residual hydrochloric acid. The final effect of both washings is the removal of all entrained substances used throughout the process. A third washing removes the salt and sodium bicarbonate.

After the skins are dried, they are mechanically finished by combing in an electrically heated (*Please turn to page 174*)

PHOTOS, COURTESY J. B. CALVA & CO.

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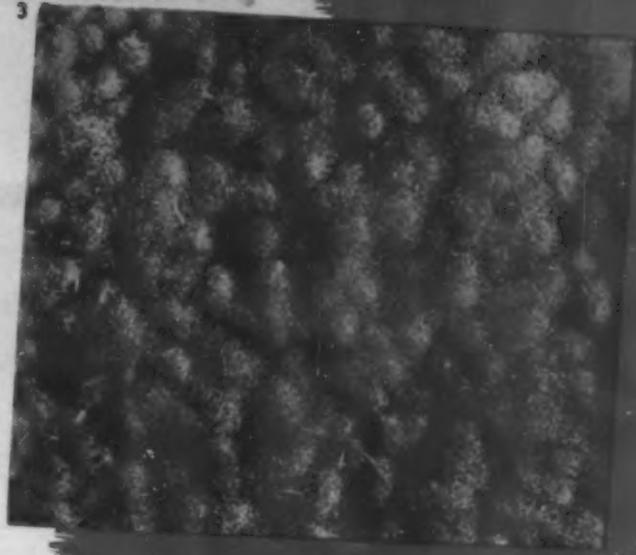

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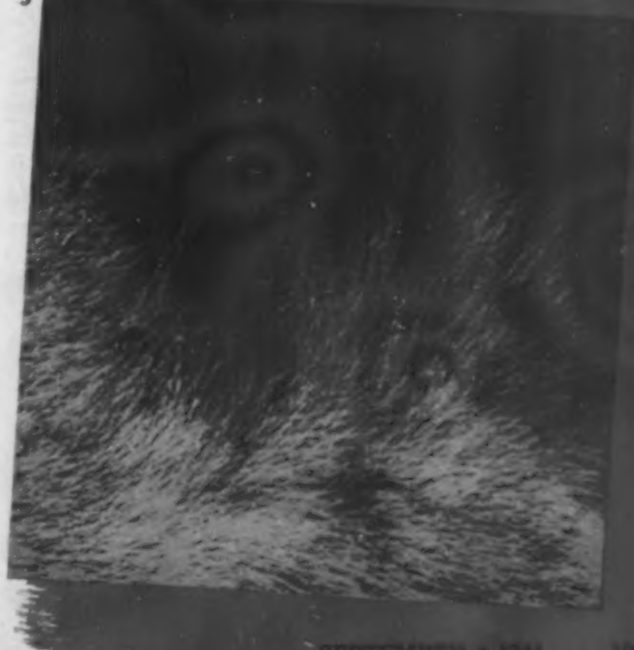
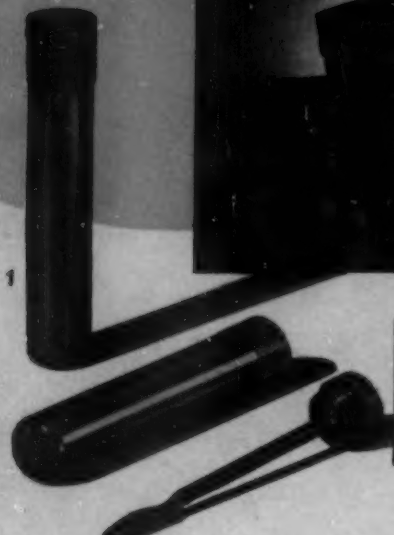


3—Magnified view of the wool fiber on the pelt before processing. 4—Chemicals are applied by means of brushing to form a plastic with the fibers. 5—The wool fiber on the pelt is shown after processing. Straightening of the fibers is a primary result of the process



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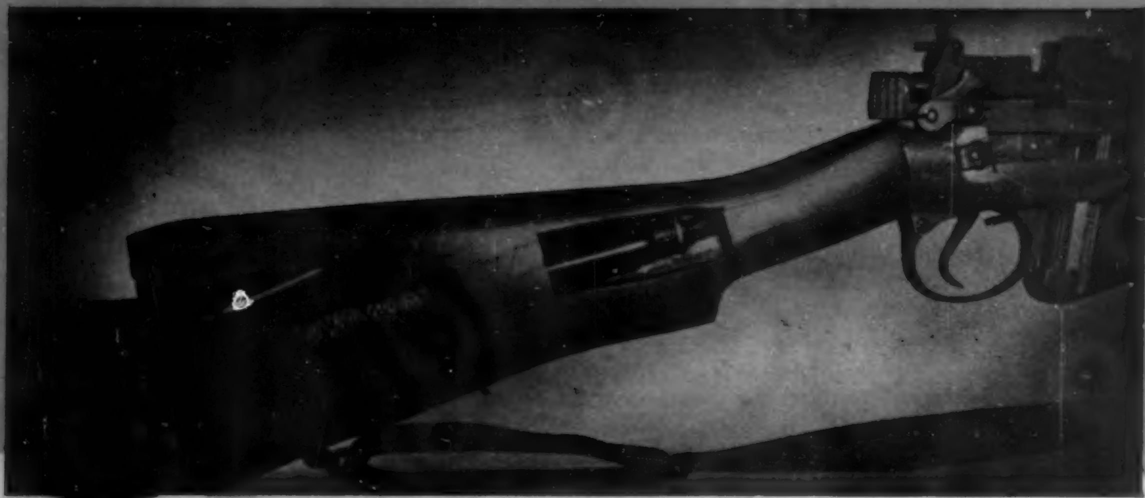


2

PLASTICS PRODUCTS

OIL BOTTLES FOR ARMY RIFLES (Fig. 1) ARE AS essential to the functioning of a gun as the ammunition, the trigger or the barrel. Unless rifles are kept in top-notch condition, undergoing constant cleaning and oiling, they quickly foul and become unusable. Consequently, in the design of the Lee Enfield rifle (Fig. 2) a space was left in the hollow 2-piece stock which accommodates one of these containers, the pull-through and a wiper.

When the bottles first were molded of plastics, a phenol-formaldehyde compound was used. However, extensive breakage and replacement necessitated the use of another material with greater tensile strength. From among the various thermoplastics that were tested for this application, cellulose acetate butyrate was finally selected as the most suitable. Due to the tendency of thermoplastic materials to creep, difficulties were encountered in molding a container that did not leak. The problem was overcome when a circular recess was located behind the thread of the cap and a washer was used which was small enough to be forced over the threads and to spring into this recess.

The bottle consists of three plastic parts: the body, the cap and the spoon for applying the oil. The cap is molded in one piece, complete with threads which must be held to a tolerance of 0.005 inch. The body has a thread molded integrally by a 12-cavity automatic die which unscrews the threaded cores by its opening action. With this type of die, a molding cycle can be completed in 22 seconds. The parts are taken directly from the machine, the washer put on with the fixture, and the spoon inserted in the top.

Credits—Material: Tenite II. Molded by Percy Hermant Ltd. for Small Arms Ltd.

THIS 18-FT. PLASTIC MODEL (Fig. 3) IS PROVING OF benefit in speeding the construction of Victory ships. By the study of the transparent model, shipbuilders are able to learn the fastest method for putting a ship together. They can inspect the model and determine whether plate A or plate B should be placed first, or whether it might not be better to put in a foundation for machinery before applying any plate.

In addition, workmen can be brought from the shipways and given visible instructions on procedure. Otherwise they must get their experience from the actual building of a ship. This training possibility is important in view of the fact that it has been necessary to change the skill of a great many workmen in switching from the construction of the Liberty ship to the Victory ship. For example, there are fewer riveters employed in building a Victory ship than for a Liberty ship.

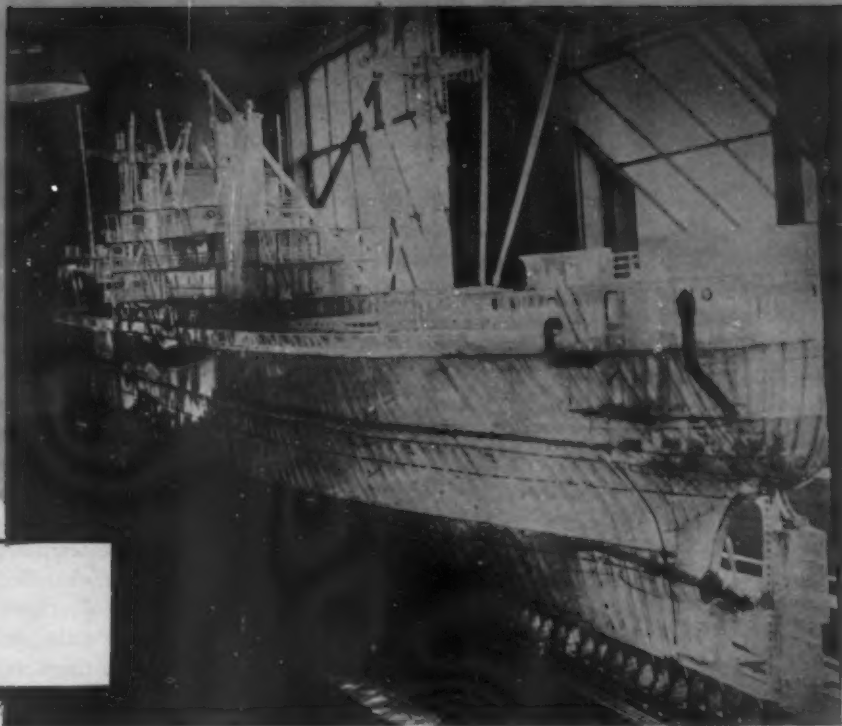
Every single part of the ship is plastic with the exception of piping lines which are of metal. During construction of this 500-lb. model, which took from December to June, workers were confronted with such problems as bending the acetate sheeting over a jig and holding the curve while heating. Having no other method at hand, they simply held the heated sheet over the mandrel until it cooled. When they wanted to make a $^1/_4$-in. rod, they cut out a square piece of acetate, turned it on a lathe and used emery paper for finishing. Practically the only tools used, outside of hand tools, were a jig for cutting shapes and a carpenter rig for cutting mandrels.

Credits—Material: Lumarith. Fabricated by Bethlehem Fairfield Ship Yard Inc.

TO THE UNINITIATED THE ARRAY OF KNOBS and buttons on the instrument board (Fig. 4) of a plane is bewildering. To the pilot, they are the pressure points of a highly sensitive body by means of which every part of the mechanism can be controlled.

This pilot-pedestal instrument panel constitutes one of the many units into which the entire board is divided. It is formed of a large rectangular phenolic laminated sheet, with holes of varying sizes cut out f om a large part of the surface. Formerly, the panel (center) was backed by an aluminum panel which served as a ground shield. However, the number of holes—approximately 80—which must be machined in the surface of the panel subsequent to the pressing operation raised the difficulty of locating the holes in exactly the same position

*Reg. U. S. Patent Office.



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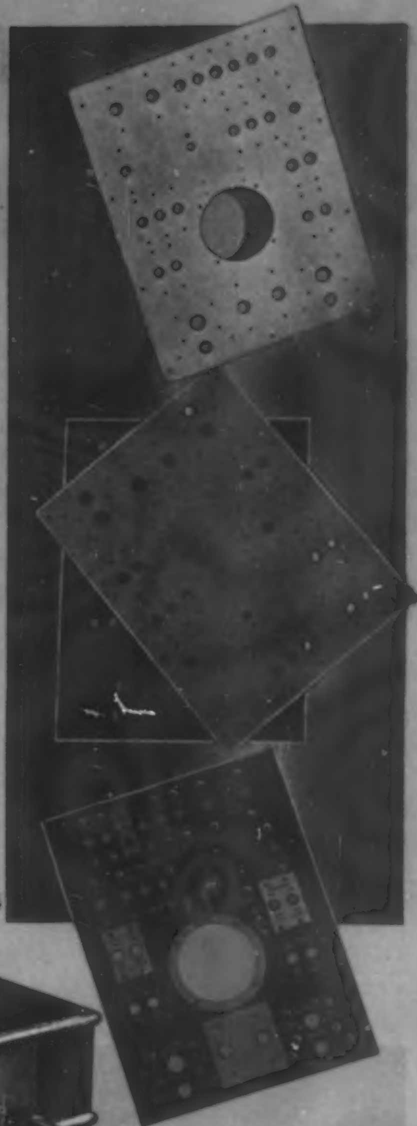

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on both panels. This difficulty was obviated by eliminating the aluminum panel and metal plating the reverse side of the plastic panel (top). The identifying data on the panel are printed on a separate veneer sheet which is subsequently laminated to the rest of the panel. Fluorescent pigment is employed in the printing of all of the instructions.

Credits—Material: Formica. Electroplating by Metaplast Corp. for Glenn L. Martin Co.

THIS TRIANGULAR SUPPLY CONTAINER (Fig. 5) IS one of the latest time-, labor-saving devices to be used in commercial laundry machines (Fig. 6). Automatically controlled by a marked cylinder that is divided into 1-min. intervals, each of the 10 plastic hoppers employed on a washer is filled with a specific washing solution. At a predetermined time, its contents are discharged into a mixing chamber which, in turn, empties into the main body of the washer. Thus, soap, bleach and bluing can be added at the proper time.

A black phenolic material was selected for the molding of these containers. Careful engineering was necessary because of the deep draw incorporated in the design of the part, and the placement of the strengthening ribs, the handle attachment lugs and pivoting trunnions. This precision molding also made imperative the use of a well-compounded, easy-flowing material. In addition to moldability, the plastic employed for these containers had to possess natural chemical resistance. Strong soaps, alkali and bleach, while necessary in the washing operation, are, in their concentrated forms, undesirable reactive agents with most materials. Since the service containers act as measuring cups in adding concentrated solutions to the washing water, it was necessary that they be made of a material unaffected by these chemical substances.

The use of phenolic containers on these automatic washing machines has had a tendency to reduce the cost of replacement and repair. In addition, these hoppers can be produced of plastic on a mass production basis.

Credits—Material: Durez. Molded by Plastic & Die Cast Products Corp. for Robot Laundry Machine Corp.

5

6

The jeeps of railroading

by GEORGE C. GRESS*

RAILWAY motor cars are the jeeps of railroading. As modern versions of the hand car, they carry section maintenance gangs and tools, pull loaded trailers and serve in a hundred and one odd jobs. These small, sturdy cars are indispensable in keeping right-of-ways in shape for heavy wartime traffic. Overseas, Army railroaders from the Bangor and Aroostook, from the Southern Pacific and every other American line have proved the versatility of the cars in speeding the reconditioning of war-torn railroads.

Essentially, these motor cars are built around a frame on which are mounted the platform, gasoline engine, transmission, four wheels and a pair of axles. A leading builder of the cars, the Fairmont Railway Motors, Inc., produces a line which includes types specially fitted for every service and every set of operating conditions. For the Army, a model is built that is adaptable to any gage track from 30 to 60 inches.

Over a period of years the engineers of this company have come to know molded plastics and to apply them in increasing amounts in the design and construction of their equipment. Specifications are rigid for any material used in the cars, since severe operating conditions are the rule—ranging from Arctic temperatures to blazing desert heat. And the men who operate the equipment are not in the habit of treating anything with kid gloves. They expect the cars to operate for miles without any repair service and to provide faithful service over long years with a bare minimum of maintenance.

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These are the requirements which must be kept clearly in mind during the design of each part. Above all, the engine and other mechanical components must be completely weatherproof, extremely simple and rugged.

Molded plastics first became important in car design as a medium of electrical insulation between wheels and axles. On most railroads, signal systems are tripped when an electrical contact is made between the two rails of a track. The electrical arrangement is such that when a train moves across the tracks at the established point, a contact is established between the rails, through the metal wheels and carriage of the railcar. The contact activates the signal system so that another train on the same track will have adequate warning. Maintenance cars, however, are intended to be manhandled off the track when a train approaches. Consequently, they must be insulated to prevent contact between the rails, and the best place to provide such insulation is between the wheel mounting and the axle.

Wheels on the lighter hand cars are pressed on to the axle and held there by a threaded nut. The desired insulation is provided by a molded phenolic sleeve (Fig. 1) which fits between the wheel hub and the axle. Both when pressed on the wheel and when removed by a shock puller this plastic sleeve is subjected to heavy strains. In shock pulling, the axle is struck with a heavy blow by a sledge hammer, the force of the blow loosening the wheel and the collar. The molded plastic collar takes that treatment without failure. Even greater

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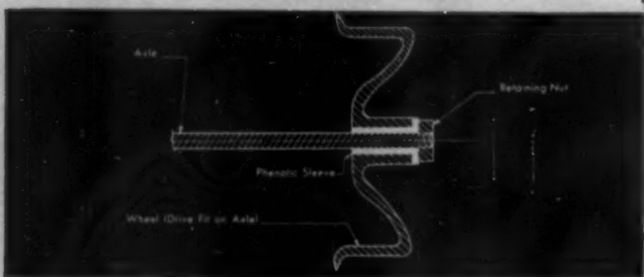

1—This molded phenolic sleeve prevents light-weight hand cars from activating railroad signal systems. **2**—*A large motor car.* **3** *and* **4**—*The timer for the ignition system is mounted in this phenolic housing.* **5** *and* **6**—*Plastic check valves are used in the engine carburetors.* **7**—*A phenolic flange insulates wheels on larger cars*

ALL PHOTOS, COURTESY MONSANTO CHEMICAL CO.

2

toughness is needed in service where shocks from track bumps and rail joints are all transmitted through the plastic collar.

In heavier cars, particularly those equipped with roller bearings, a different wheel mounting method is used. In this equipment, the wheel is bolted by 8 bolts to a flange on the bearings (Fig. 7). To provide insulation, a matching flange of high-impact cord-filled phenolic is inserted between the wheel hub and the mounting plate to prevent metal to metal contact. A ring of holes is molded into this phenolic part to accommodate the assembly bolts, and a short collar is provided around the center hole. Since metal bolts can also act as conductors, each is fitted with a vulcanized fibre bushing.

Cord-filled high-impact phenolic was selected for use on these heavier cars because of the high-shock loads to which the parts are subjected. This material provides approximately ten times the impact strength of wood-filled materials —higher than many metals. Molding is carried out in a single-cavity semi-positive compression mold designed with a large loading volume to handle the bulky compound.

The success of these applications over extended service periods led to the development of a plastic timer block. Following the basic requirement for simplicity, timing for the ignition system is provided by a unit which rides on the flywheel shaft (Figs. 3 and 4). The timer is designed so that a momentary contact is established at each revolution of the wheel. The unit incorporates a coil, terminal clips and contacts. The molded phenolic block serves as a mounting for the contacts, a housing for the coil and a base for the clips. If metal instead of plastic were used for this application, insulation material would be required at numerous points throughout the unit. Because of the intricate shape of the piece and the close dimensions needed, molding was a precision job. The mold is of 2-cavity semi-positive design, with a loose mold piece to provide the coil recess.

The engines in these railway cars also employ plastics. The carburetors are designed with spring-loaded check valves which control the flow of air and of air-gasoline vapor. Proper functioning of the engine requires these valves to open quickly and yet snap closed to form a tight seal when flow is reversed. Since operating requirements demand that the valve disks possess high dimensional stability and extremely low liquid absorption, general-purpose phenolic is used.

Credits—Material: Resinox. Molded by Northwest Plastics, Inc., for Fairmont Railway Motors, Inc.

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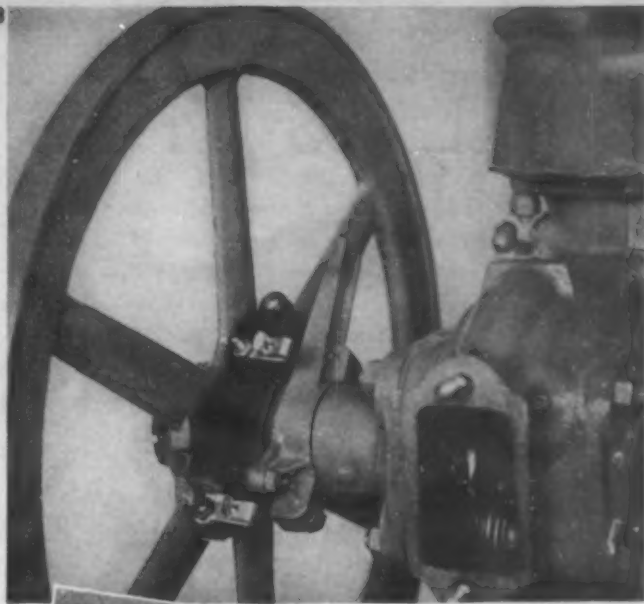

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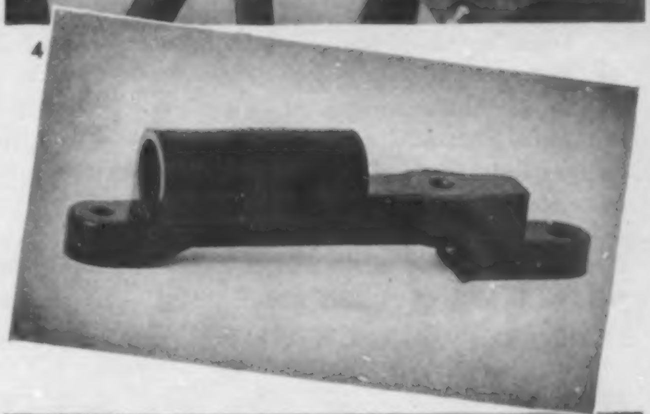

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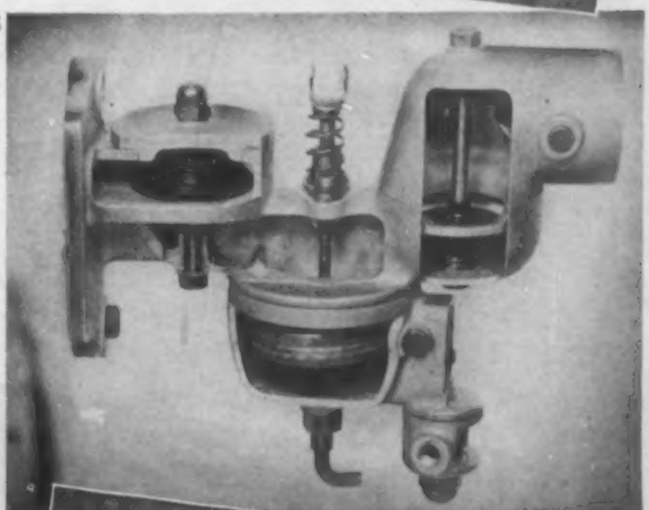

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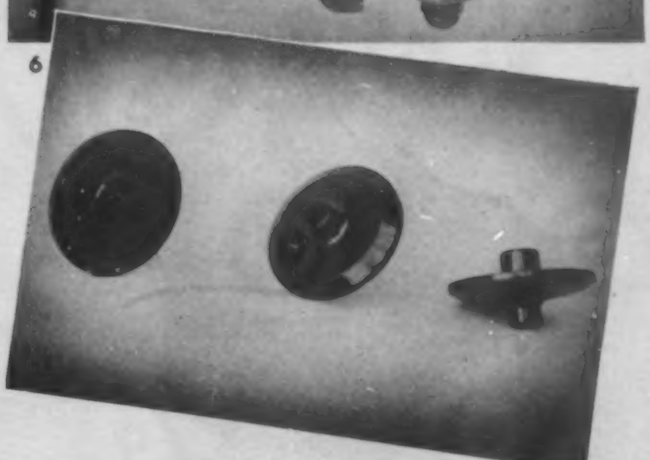

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PLASTICS in REVIEW

1 The torpedo-shaped rubber plugs with which defense workers protect their ears against deafening machine noise have a way of getting lost. To guard against this exigency, many industrial workers make use of this Bakelite cellulose acetate case which has a compartment for each plug and a third cavity for the lubricant which facilitates the insertion of the plugs in the ears. Molded by the Plastic Die and Tool Corp., the cases are being supplied to workers by a number of manufacturing plants

2 With gasoline restrictions increasingly stringent, motorists find difficulty in adjusting cars geared to high speeds and rapid acceleration to the limitations imposed by inferior gasolines and reclaimed tires. These scientifically designed pressure controls, known as Mileage Masters and consisting of a body, cap, plate, piston rod and head, spacer and tee, prevent power surges and provide controlled acceleration. Injection molded of Tenite II in a 7-cavity combination mold in 60 sec. cycles by Plas-Tex Corp. for Blue Diamond Corp., these controls withstand under-hood temperature of 180°. The vacuum tube is of Saran

3 In the back alleys, on the farm, in the theatre. Harmonicas have had a place in every walk of life. And now they are serving with our men overseas. Of a size to fit into a hip pocket, they bring music to the front lines where other instruments are barred because of size. Plastic Mold & Tool Co. are molding these harmonicas of Durite for the Harmonica Reed Co. Produced in one-cavity dies, these instruments must be held to close tolerances so that the removable reeds can be slipped into the slots molded for them in each prong. When the reeds are in place there must be no air space around them through which the wind can escape

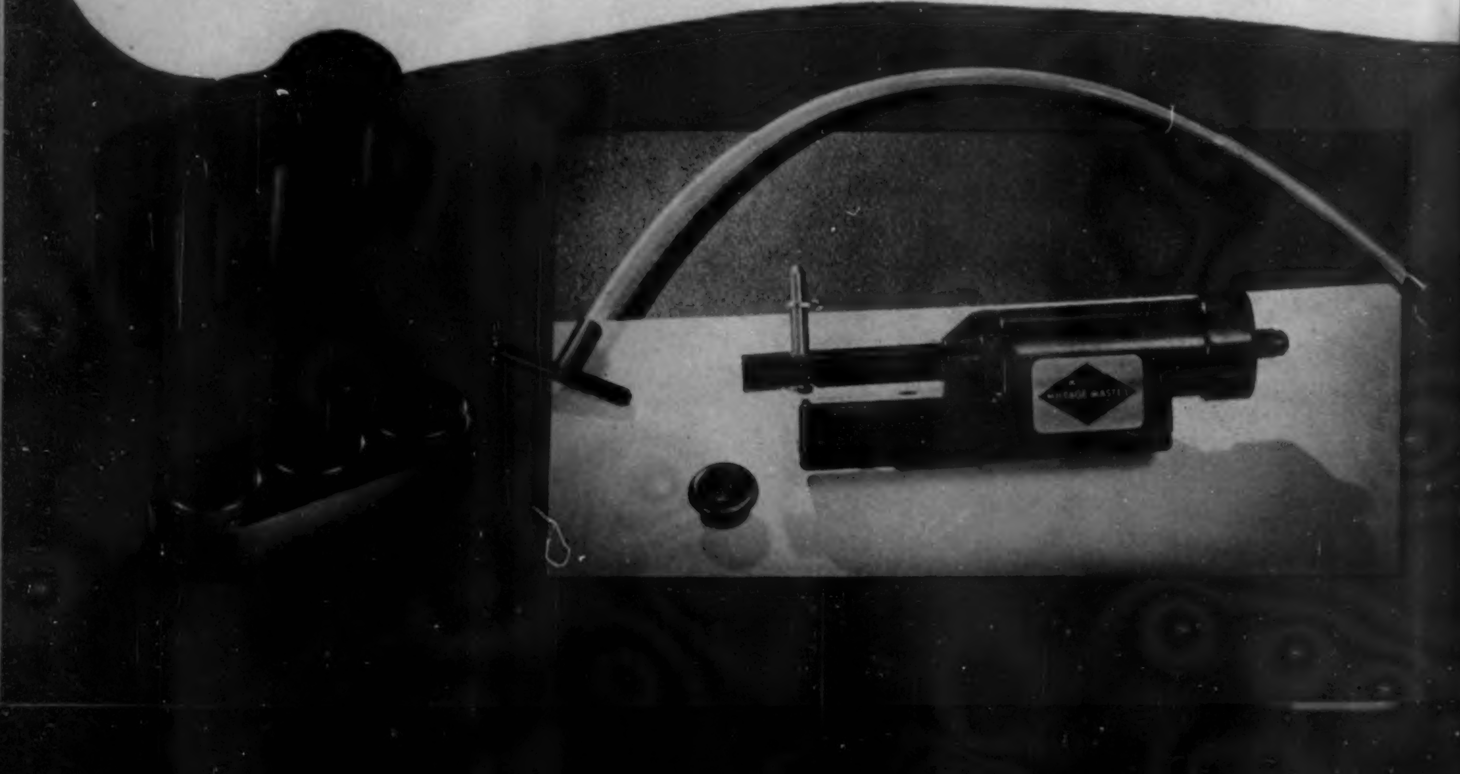
4 Skilled radio technicians utilize these alignment tools to bring padding condensers into final adjustment. Molded of a Durez phenolic compound by Globe Tool and Molded Products Co. for General Cement Mfg. Co., the tool has two major parts. The barrel, hexagonal in shape in its inner working end, is topped by a small knurled head. The plunger is kept from protruding beyond the end of the barrel by a spring

5 No one will deny the essentialness of cosmetics as a morale builder. These attractive lip rouge boxes are molded of Tenite by Plastic Die and Tool Corp. for Tru-Lip Cosmetics on a 12-cavity die, six tops and six boxes being made on one shot. The containers come in deep red, black, ivory and other colors

6 This computing device, called the Jernstedt Electroplating Computer, does for the electroplater and plating chemist what the slide rule does for the engineer. Through the use of logarithmic scales it eliminates lengthy calculations. It is made of Vinylite laminated sheeting for Hanson-Van Winkle-Munning Co. by Bastian Bros. Co. Printing is done on a matte surface after which the sheet is laminated with a transparent film of the same basic stock

7 At one time, the surface oxidizing treatment of aluminum airplane parts at a Curtiss-Wright Corp. plant was complicated by the susceptibility of the 28,000 gal. treatment tanks to attack by the chromic and sulfuric acid anodizing solutions. This difficulty was overcome when the tanks were lined with sheets of Lucite which offered the further advantage of being unaffected by sudden temperature changes. In addition, these plastic sheets proved to be less expensive, lighter, and less subject to breakage

8 With telegraph facilities bearing a large burden of wartime communication, each part of the system must function with absolute fidelity. For example, Western Union Telegraph Co. found these thimble tape cutters, formerly molded of a wood-base and a cotton-base compound, to be less susceptible to breakage if made of Plexiglas. By using a single-shot mold with six removable inserts, General Electric Co., Plastics Divisions, can at one time injection mold these cutters in six different sizes

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OUNCES PER "A" GALLON
FACTOR "B"
LOW
GALLONS
METRIC CONVERSION EQUIVALENTS
METAL FACTOR
CYANIDE FACTOR
OUNCES ADDITION
POUNDS ADDITION
POUNDS & OUNCES
"C"
"D"
JERNSTEDT ELECTROPLATING COMPUTER
HANSON-VAN WINKLE-MUNNING CO.
MATAWAN, N. J.
U. S. A.

Production of synthetic resins in 1943

A RECORD production of over 651 million pounds of synthetic resins in the United States during 1943 is reported in statistics of commercial production and sales of synthetic resins compiled and released by the United States Tariff Commission. This represents an approximately 50 percent increase in production over that of either 1942 or 1941.

Output of resins derived from cyclic compounds, which includes the coal tar group, increased from 284 million pounds in 1942 to 379 million pounds in 1943, an increase of 33 percent to an all-time high. The previous peak of 334 million pounds was reached in 1941. The production of resins derived from noncyclic compounds increased from 143 million pounds in 1942 to a record 273 million pounds in 1943, an increase of 90 percent.

The total of phenolic resins of all types produced reached 164 million pounds, an increase of 12 percent over 1942. An enlightening breakdown of the figures for the phenol-formaldehyde resin into such end uses as molding, casting, laminating, protective coatings and adhesives, is given in Table I. The production of urea-formaldehyde resins rose from 37 million pounds in 1942 to 54 million pounds in 1943, an increase of 43 percent. More than half of the output of this resin went into adhesives.

A record figure of 204 million pounds was reached for alkyd resin production in 1943, an (*Please turn to page 192*)

TABLE I.—UNITED STATES PRODUCTION AND SALES OF CERTAIN PLASTIC MATERIALS IN 1943

Product	*Production*	*Sales*		
		Quantity	*Value*	*Unit value*
	lb.	*lb.*		*per lb.*
RESINS FROM CYCLIC COMPOUNDS (COAL-TAR, ETC.): TOTAL	378,846,000	337,800,000	$76,701,000	$0.23
Alkyd resins (phthalic anhydride)[a]	154,385,000	124,992,000	23,649,000	0.19
For protective coatings	153,398,000	124,184,000	23,451,000	0.19
For textiles	514,000	[b]	[b]	...
For molding and casting	291,000	[b]	[b]	...
For miscellaneous uses	182,000	[b]	[b]	...
Phenolic resins, total	142,912,000	[c]	[c]	...
Phenol-formaldehyde	124,204,000	118,395,000	38,210,000	0.32
For molding	61,424,000	60,371,000	21,971,000	0.36
For casting	2,838,000	2,845,000	1,270,000	0.45
For laminating	22,606,000	18,353,000	4,478,000	0.24
For protective coatings	15,519,000	15,273,000	5,140,000	0.34
For adhesives	10,290,000	10,247,000	2,079,000	0.20
For miscellaneous uses	11,527,000	11,306,000	3,272,000	0.29
Cresols or cresylic acid-formaldehyde	16,805,000	13,192,000	3,986,000	0.30
Other phenolic resins	1,904,000	[c]	[c]	...
Mixed phenolic resins	21,395,000	18,567,000	3,915,000	0.21
Phenol-cresol-aldehyde	10,322,000	8,405,000	1,549,000	0.18
Cresol-xylenol-aldehyde	1,164,000	695,000	126,000	0.18
Other mixed phenolic resins	9,909,000	9,467,000	2,240,000	0.24
Polystyrene	6,737,000	6,374,000	2,239,000	0.35
Other cyclic resins[d]	53,416,000	56,280,000	4,702,000	0.08
RESINS FROM NONCYCLIC COMPOUNDS (NON-COAL-TAR): TOTAL	272,665,000	229,767,000	101,290,000	0.44
Alkyd resins, total	49,644,000	45,912,000	8,384,000	0.18
Abietic acid, abietic and maleic acids	11,789,000	12,263,000	1,416,000	0.44
Fumaric acid	9,035,000	6,222,000	1,815,000	0.29
Maleic anhydride	24,803,000	23,420,000	4,122,000	0.18
Other alkyd resins	4,017,000	4,007,000	1,031,000	0.26
Nitrogen noncyclic resins:				
Urea-formaldehyde	53,859,000	51,733,000	13,288,000	0.26
For adhesives	32,546,000	30,521,000	6,966,000	0.23
For protective coatings	4,857,000	4,559,000	1,182,000	0.26
Miscellaneous uses	16,456,000	16,653,000	5,140,000	0.31
Alcohol polymerization resins[e]	522,000	415,000	326,000	0.79
Polyvinyl alcohol-aldehyde	14,435,000	12,349,000	8,232,000	0.67
Other noncyclic resins	154,205,000	119,358,000	71,060,000	0.60
TOTAL FOR RESINS, 1943	651,511,000	567,567,000	177,991,000	0.31
TOTAL FOR RESINS, 1942	426,731,106	373,185,293	149,680,000	0.41
TOTAL FOR RESINS, 1941	437,799,687	348,307,470	117,255,951	0.34
TOTAL FOR RESINS, 1940	276,814,363	201,099,650	59,368,339	0.30

[a] Includes anhydride-alcohol-oil chemically combined.
[b] Data are confidential and may not be published; however, they are included in "Alkyd resin" total.
[c] Quantities included in "Other cyclic resins" total.
[d] Includes petroleum-derived cyclic resins.
[e] Includes allyl alcohol and furfuryl alcohol polymerization resins.

Plastics in structural design

Discussion of the effects of holes, corners, notches and abrupt changes in section on the performance of molded structural parts

by V. E. MEHARG and L. E. WELCH†

As INCREASING attention is given to the use of molded plastics in structural members and in other "load-carrying" applications, the question of proper design arises. There is apparent a degree of uncertainty, or even confusion, as to whether these plastics should be handled to conform with conventional design practices, or whether entirely new principles should be adopted.

In the plastics industry, certain design features are employed which detract from the strength and service life of many molded products. Some of these are: 1) sharp inside corners, 2) notches in the surface, 3) rapid or abrupt changes in section thickness, and 4) poor discretion in the location of holes in the molded parts. These discontinuities or "stress-raisers" produce, in adjacent regions, what are commonly known as "stress-concentrations." The purpose of this paper is to discuss the problem of stress-concentration in both a theoretical and practical manner and to present some complementary data on the behavior and characteristics of several molding materials when subjected to applied stress after being fabricated into parts containing "stress-raisers."

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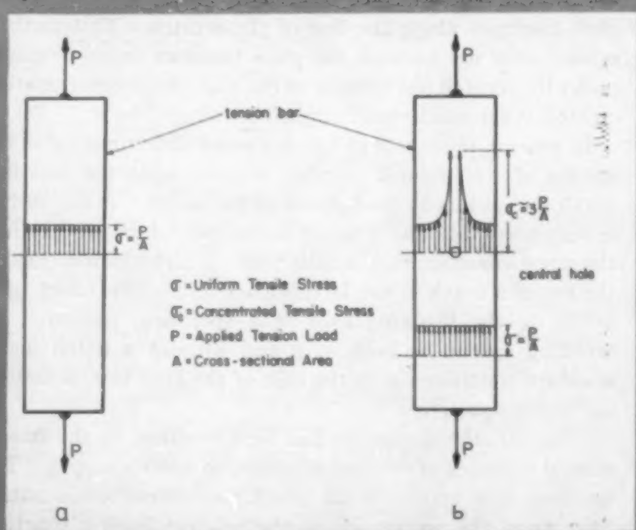
In considering the fundamentals of stress and strain, the first point to be clearly understood is that plastics in their finished form exhibit precisely the same mechanical characteristics in structural applications as do all other materials of construction—steel, aluminum, cast iron, concrete and wood. However, while the mechanical characteristics are the same, the magnitudes of the various mechanical properties are different for each material. Thus, any theoretical or practical analysis of the behavior of a structural member under stress is applicable to plastics as well as to metals, concrete, wood and other construction materials.

By definition, stress is the load per unit area acting at any point within a stressed body. For purposes of clarity, let us first examine the case of a pure tension stress such as would develop in a bar (Fig. 1) under an applied tension load (P) acting at each end. In Fig. 1a, every particle in the bar with the exception of the ends is acted upon by the same stress which is uniform across the section. This stress—the load (P) divided by the cross-sectional area—is denoted simply by the Greek letter σ.

It is obvious from the definition of stress that if the load

1—This drawing shows the effect of a central hole on the stress distribution in a tension bar. The bar at the left does not have a center hole. 2—This is a theoretical stress-concentration curve for flexure

1



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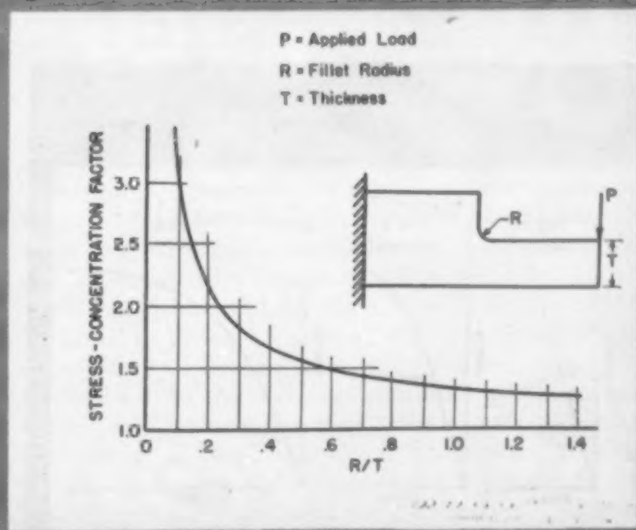


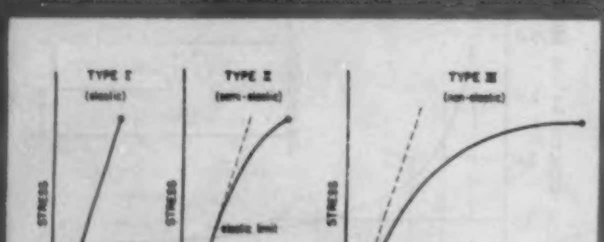
* Reg. U.S. Patent Off.

(P) is held constant, the stress in the bar will vary inversely with the cross-sectional area. This brings up a most important question in design. Given a certain load (P) which must be carried by the bar, what should be the cross-sectional area (A) of the bar if satisfactory operation is to be insured? This question can only be answered if the stress-strain characteristics of the proposed material are known. (Strain is defined, for small deformations, as the unit of extension and is directly related to the stress as shown in Fig. 3 and discussed in greater detail in later paragraphs.) The cross-sectional area will be determined by the maximum allowable working stress that may be imposed upon the materials for the conditions under which the part is to operate. If this maximum allowable working stress is known, then the problem is immediately solved provided there are no stress-raisers present in the structure under consideration.

Let us suppose, however, that it is necessary to have a very small hole in the center of the bar. The design problem is immediately complicated since the presence of the hole produces a stress-concentration in the adjacent region regardless of the material from which the bar is fabricated. This stress-concentration is not caused by the reduction of the cross section but results from the discontinuity effect produced by the hole. Such a stress-concentration is pictured in Fig. 1b. This diagram shows that the stress-distribution through the cross section some distance away from the hole is the same as in Fig. 1a for the same load (P) and the same cross-sectional area (A). However, the stress-distribution across the bar at the hole is no longer uniform, but is a variable with the tensile stress disproportionately high at the edge of the hole. It can be shown theoretically that the maximum stress at the edge of the hole, denoted by σ_e, is three times the uniform tensile stress in parts of the bar away from the hole.

There is considerable experimental evidence to show that such a condition actually exists in a tension member containing a central hole which is small compared to the width of the bar. This is the simplest example of stress-concentration possible, but it suffices to illustrate the point of this discussion, which is: If compensation for the stress-concentration had not been made in the original computation of the cross-sectional area of the bar, failure might result under the given load (P). Of course, if the hole is necessary, then the cross-sectional area of the bar should be increased threefold in order to reduce the stress at the edge of the hole to the magnitude of the maximum allowable working stress. However, this increases the weight threefold. It is obvious that the elimination of the hole is desirable if possible.

3—*Three stress-strain diagrams for rigid plastics*



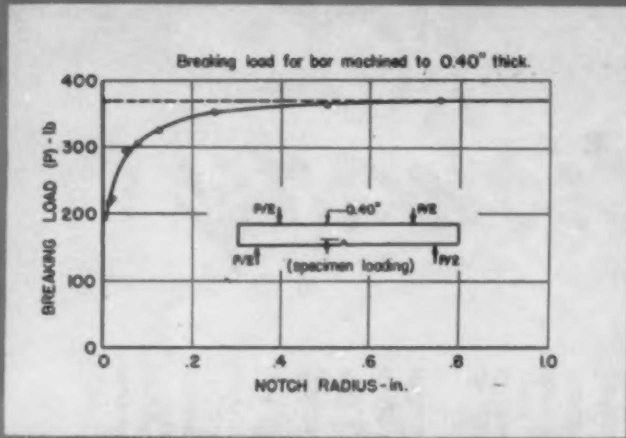
A less obvious but nevertheless important source of stress-concentration is the ever-present variation in section thickness which occurs in structural members. Analogous to this is the sharp inside corner often used in boxlike or ribbed structures. Sharp inside corners and those produced by differences in section thickness may be more severe stress-raisers than holes. Stress-concentration resulting from sharp inside corners—such as occur between two sections at right angles to each other and connected along one edge—can be diminished by modifying the change in section or direction by the insertion of a liberal fillet radius. The fillet radius eases the change of stress from one section to the other or the change in direction of stress just as, in the flow of liquids, the tapered union or radius elbow in a pipe aids streamline flow and reduces turbulence. Just as a restriction or sharp corner in a pipe line causes turbulence, so an abrupt change in section or a sharp corner produces stress-concentration or abnormally high stress in a stressed body.

The effect of a fillet radius in reducing stress-concentration can be shown theoretically. Figure 2 indicates the theoretical relationship between the stress-concentration factor and the fillet radius that is obtained from a fundamental study of the bending of a structural member such as that shown in this drawing. (The stress-concentration factor is merely the ratio of the abnormal stress existing at a point of stress-concentration to the normal stress which would exist at the point if the stress-raiser were not present.) The curve shown in Fig. 2 has been experimentally verified by photoelastic analysis, and the main purpose in presenting it here is to show the very rapid decrease in stress-concentration induced by a very slight increase in the fillet radius. This is a very important property of fillets. A useful rule in design is: *make the radius of the fillet at least equal to the thickness of the thinnest section involved.* The reason for this statement is apparent from a study of Fig. 2, which shows that for a ratio of fillet radius to section thickness (R/T) of one/one, the stress-concentration factor is only slightly greater than unity. This indicates only a slight stress-concentration in the region of the fillet for this condition.

Still another source of stress-concentration is the presence of a notch in the surface of the body under stress. Notches, which may result from machining or scratching, sharply lower the breaking strength of the part. This fact is clearly illustrated in glass cutting where the surface of the glass to be cut is first scratched or notched with a diamond point or some other suitable means. The glass is then bent in such a way that the notched surface is under tension, whereupon the glass fractures along the line of the scratch. This method is successful not because the glass becomes slightly thinner under the scratch but because of the high stress-concentration created at the notch under applied bending.

In general, the extent to which a notch is detrimental to the service of a structural member depends upon the location, depth and radius at the bottom of the notch. If the radius is very small, like the V-notch radius used in impact testing, the stress-concentration is quite high—a fact which suggested the use of a notch in the Izod impact test. The effect of a notch on the breaking load of a specimen, measured by breaking specimens both with and without a notch under standard conditions as in the case of the Izod test, is defined as "notch-sensitivity."

Thus far, the discussion has been confined to the fundamental concepts of stress-concentration and its causes. The question now arises—What effect does stress-concentration have upon the service life of the product from a practical standpoint? To answer this query it is necessary to analyze



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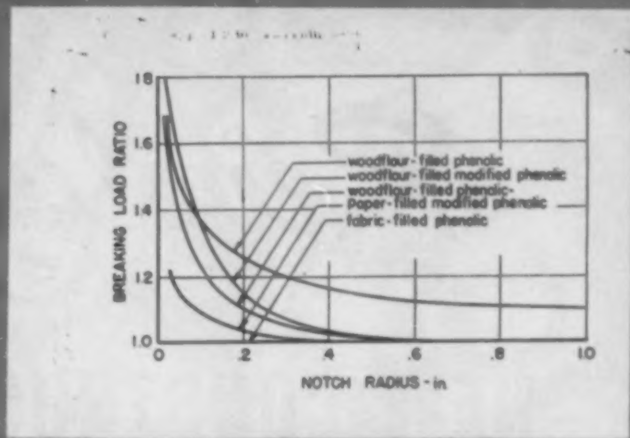

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4—Effect of notch radius on the breaking load of a notched flexural bar of woodflour-filled phenolic molding material. 5—Breaking load ratio as a function of notch radius for several rigid plastics

the stress-strain properties of the various rigid plastics that have possibilities in the field of structural engineering, and Fig. 3 illustrates the three most common types of stress-strain diagrams for plastics. Figure 3a shows the perfectly elastic or "brittle" type of material in which the stress is directly proportional to the strain from no load to fracture. This is the definition of perfect elasticity, the proportionality constant between stress and strain being known as the modulus of elasticity. Such materials as wood-flour-filled and mineral-filled phenolic molding materials come under this classification and are more commonly called brittle materials.

Figure 3b illustrates the behavior of a material which exhibits perfect elasticity up to a definite stress value—the "elastic limit"—but which, upon further stressing, shows a non-linear relationship between stress and strain. Materials such as the fiber-filled and fabric-filled phenolics and some thermoplastics are examples of this type. The latter portion of the stress-strain diagram beyond the elastic limit is referred to as the "plastic" region, or the region of permanent deformability. Translated into physical terms, the latter portion of the diagram means that the material may be permanently deformed without fracturing. On the other hand, a perfectly elastic material (as defined by Fig. 3a) cannot be permanently distorted under short-time or under static stressing.

Still a third general type of material is represented in Fig. 3c. This type shows no perceptible range of perfect elasticity but exhibits a plastic type of deformation through the entire range of the stress-strain curve. Materials having extremely flexible resin and filler combinations may be of this type. Under static loading conditions, however, this type of material does not occur frequently in rigid plastics. These three fundamental types of rigid plastics will be referred to for the remainder of this article as Types I, II and III, respectively.

The next step is to examine the effect of stress-concentration on each of these types of material with specific reference to ultimate mechanical failure. The concepts of stress-concentration presented in the previous paragraphs were based upon the assumption of perfect elasticity. Accordingly the stress-concentration factor of 3 for a small hole in a tension bar is valid only as long as the stress-strain characteristics of the materials are elastic. As soon as plastic-type deformation takes place, the stress-concentration factor decreases, because the material in the region of the stress-raiser flows, allowing the stress to build up in other portions of the body and leaving only a progressively smaller elevation in stress in the region of the stress-raiser. Therefore, the stress differential and, consequently, the stress-concentration factor decrease. It is easy to see that a perfectly elastic material, exemplified by Type I, will exhibit a relatively large stress-concentration at fracture in the region of a stress-raiser. Consequently it is termed "notch-sensitive." Glass is a Type I material, a fact that makes clearer the reason why the scratch method of glass cutting is so effective. Conversely, glass in general is a poor materia for structural applications, in many instances, because of its notch-sensitivity. To a varying extent this is also true of rigid plastics having woodflour or mineral fillers, and of some of the pure phenolic resin materials. If it is necessary to use materials such as these in the fabrication of load-carrying or structural members, great care must be exercised in the design of the molded parts to keep them free from stress-raisers—holes, notches, abrupt changes in section and sharp inside corners.

Type II and Type III materials, the semi-elastic and non-elastic varieties, are relatively less notch-sensitive than Type I materials. Because of the plastic "deformability" of the material, a stressed part fabricated for Type II or Type III, with stress-raisers essential in the design, will exhibit a tendency to relieve stress-concentration as the ultimate strength is approached. This characteristic of reducing stress-concentration prior to ultimate fracture is somewhat in proportion to the amount of permanent deformability available within the material. A material that shows a large degree of "plastic" deformability will relieve stress-concentration to a greater extent than a material of lesser permanent deformability until the perfectly elastic materials, which show little or no tendency to alleviate stress-concentration, are considered. Thus, materials such as fiber- and fabric-filled phenolics which are of the Type II variety would be considered as *not* notch-sensitive. Experiments, described in the following paragraphs, substantiate this reasoning.

Figure 4 shows the results of "pure bending" flexural tests on specimens of a woodflour-filled phenolic material notched in the center as shown with various notch radii. It is evident that as the radius of the central notch is decreased, the breaking load also decreases in the manner shown. This indicates that the stress-concentration increases as the radius at the bottom of the notch is *(Please turn to page 182)*

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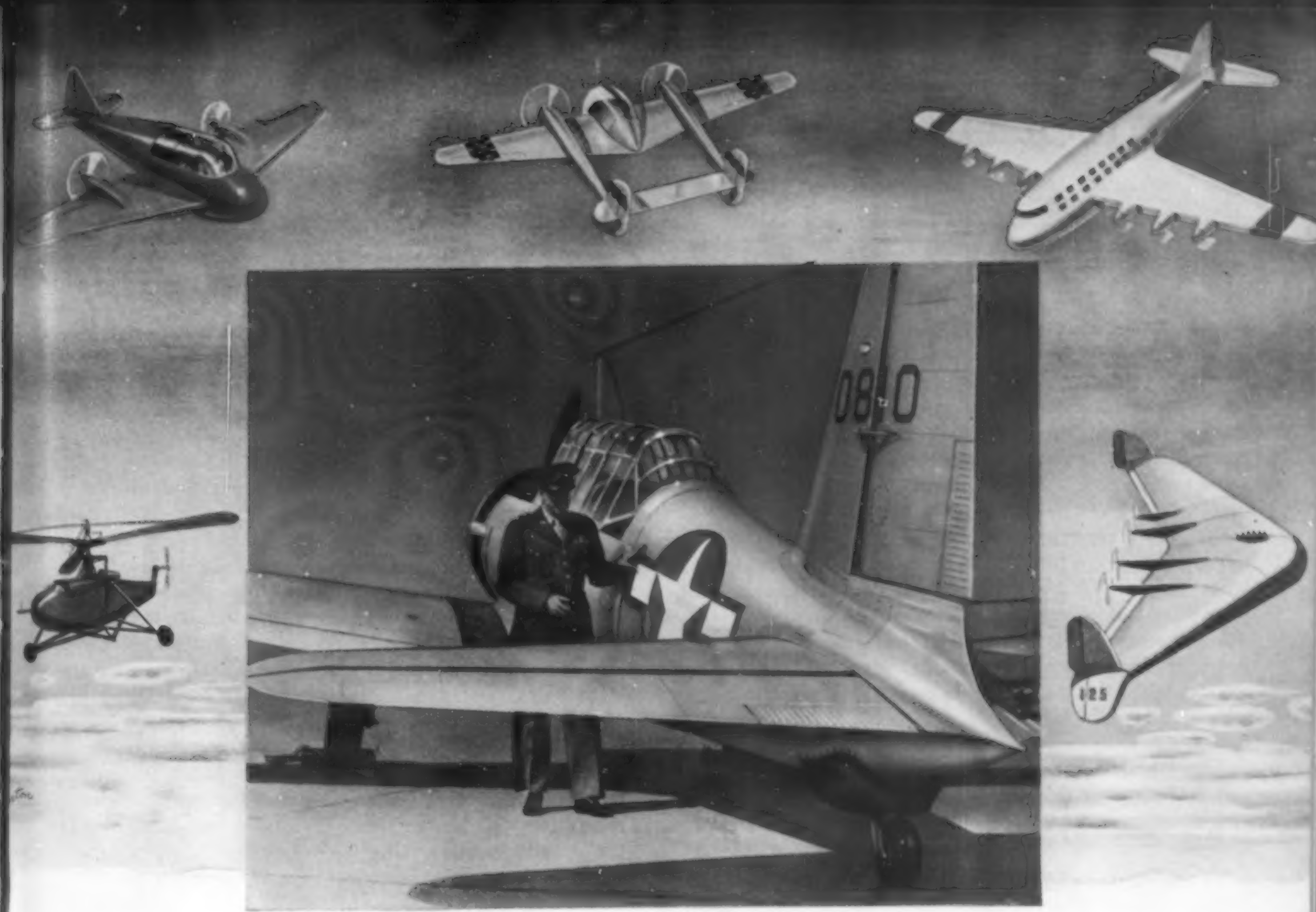
AN INNOVATION in plastics is this remarkable product: ***a special low-pressure Plaskon resin reinforced with pliable, woven glass cloth, forming a completely new and widely adaptable construction material!***

This exceptional development, although restricted for use at present, offers industry an engineering and design material with revolutionary possibilities in the future. Its great strength, light weight and ease of fabrication especially meet the needs of large structures, where stress and strain must be predictable. Outstanding feature of this new resin is the fact that only enough pressure is required in forming a structure to bring the fabric plies in close contact.

This new low-pressure Plaskon resin has made possible the world's ***first*** plastic primary structural member for aircraft. Two laminated skins of Plaskon resin reinforced with flexible glass fabric, separated by and bonded to a balsa wood core, were molded for the main fuselage of the BT-15 trainer plane shown above. This is an outstanding example of stress-skin construction for aircraft. Completely eliminated was the necessity for reinforcing members such as bulkheads, stringers, ribs and cross-ties, despite the fact that all flight loads are transmitted through this main fuselage. The tail cone and side panels of the BT-15 plane also were fabricated from the Plaskon resin and glass cloth combination, with integral molded ribs instead of a balsa core. Development and flight-testing of this entire achievement are credited to the Army Air Forces Materiel Command, Wright Field, Ohio, aided by Plaskon engineers.

In making the results of their successful research available to commercial plane builders, the Army Air Forces emphasized several exceptional advantages of the ***permanent*** Plaskon Resin-glass cloth construction material: great savings in fabrication time and expense, lower air resistance, greater plane speed, less buffeting and vibration, exceptional strength.

Plaskon advancements in resin have made possible many outstanding developments for industry and the individual. Plaskon resin research and experience may be of valuable assistance in your manufacturing and sales programs — ask for their help.



Control of compression equipment

by C. F. MASSOPUST* and ANTHONY J. POTTS**

THE compression molding of any thermosetting plastic material is an operation which has as its basic objective the completion of the polymerization of a resin that has been advanced to some lower stage of polymerization by the resin producer. In other words, a molder of thermosetting materials completes a chemical reaction which was initiated by the raw material supplier. These thermosetting resins are polymerized by the plastic molder through the application of a certain amount of heat and pressure for a certain period of time, using any of a number of types of molding presses.

Basically, compression molding presses serve one function—to provide a means for applying pressure to the molding material contained in the cavities of the die. Heat is supplied from an outside source and is delivered to the die or mold either through pipes, in the case of steam or superheated water, or through electrical leads, in the case of electrical resistance heating. Most production installations use steam or water as a source of heat.

Generally speaking, of the three factors (heat, time and pressure) involved in molding thermosetting materials, the correct amount of heat is the most important and the most difficult to control. For example, most phenol-formaldehyde compounds are molded at temperatures of about 320° F. If an attempt is made to mold the material at a much lower temperature, complete polymerization will not occur regardless of the pressure applied or the length of time the material is held at this pressure and temperature.

Naturally, incomplete curing, or polymerization, of the material results in a low-quality molded article which may be a reject at the molder's plant due to visible defects or which may break down in service. The physical, electrical and chemical properties of a molded thermosetting article are impaired by incomplete cure due to low temperatures during molding. Most materials, especially the ureas, are also adversely affected by over-cure due to molding at excessive temperature or to molding for too long a time at optimum temperature conditions.

Temperature control becomes even more important where a cooling cycle is necessary. In molding to extremely close tolerance or in the molding of fixed-capacity condensers using mica-filled compounds, it is often necessary to cool the parts just prior to their ejection from the mold. The human factor in such molding practices is not always sufficient to control quality. On some installations where, for example, a part is to be cured 4 min. and cooled 2 min., the heat recovery varies so widely at the start of each heat-cure cycle that the parts are actually subjected to exact curing temperature for from 1.5 to 3.5 min. and, in one actual test, the pieces were cured for as short a time as 0.75 minute. At times it is not possible to predict with any degree of exactitude what the quality of the production will be.

It is obvious that in plastic compression molding we have a chemical reaction—the efficiency of which is controlled directly by heat, pressure and time. Molding equipment manufacturers have provided excellent means for the control of pressures and of the time cycles used in a molding operation. Oddly enough, little has been done to consider such operations in their true light as basic chemical problems vitally dependent upon proper temperature control.

Practically all compression molding installations make use of only two controls—a steam-pressure gage and a timer—and, in most cases, the timer consists of a clock with or without a sweep-second hand. At the start of a production run, the steam pressure is adjusted to provide what is assumed to be the correct molding temperature. A temperature check may or may not be taken on the die surfaces with a pyrometer. The operator proceeds to mold, using time cycles specified by the engineering department, which generally consist of a record based upon past experience. Many self-contained presses and some equipment operated from accumulator systems are now equipped with controls which allow for fully automatic or semi-automatic operation. But all are based on a time-control cycle. If temperatures are too low or too high, a time control has little direct bearing on the quality of the molded article.

The tendency of press operators, working under an incentive wage plan, to attempt to exceed the base rate and earn a bonus by slicing time from a stipulated cure cycle results in poor quality parts which may or may not be discovered in the usual inspection processes. Such conditions are especially prevalent where adequate supervision is not present—a condition that sometimes exists during the second and third shifts of a working day. Even on automatic or semi-automatic equipment, operators are able to readjust cycle controls or manually operate the machines for short periods so as to reduce time cycles in spite of breakdowns, sticking of material or "dead" cavities.

In view of the above-mentioned conditions, an attempt was made to devise 1) a control system which would operate a molding press on a temperature basis, and 2) a method which would accurately record the number of correct molding cycles completed on a molding press. This latter control would insure the proper treatment of any compression molded product. With these objectives in view, four control systems were designed.

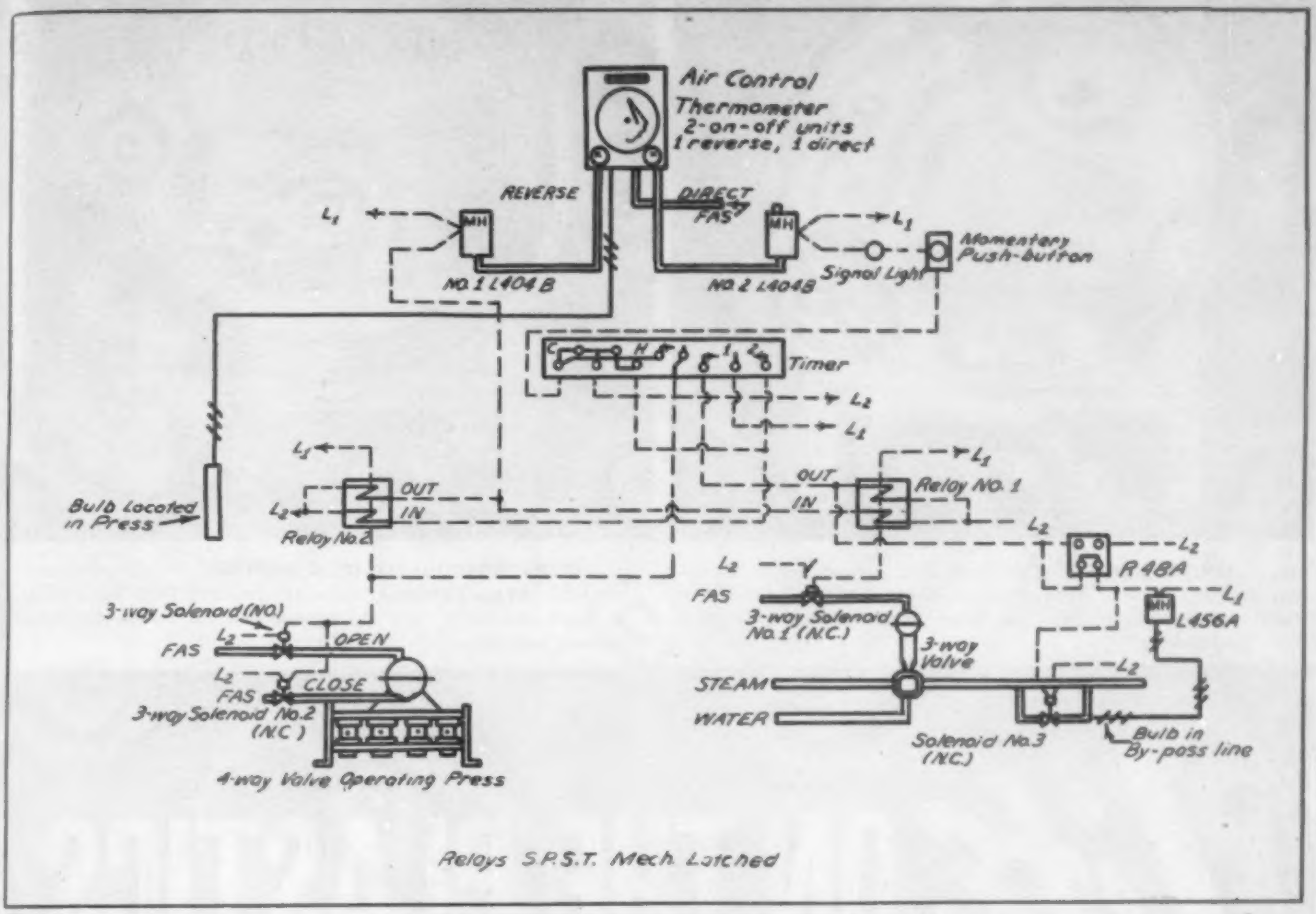
For the purpose of developing an all-inclusive control setup, it was assumed that the problem under study involved a molding cycle, which included a cure at a definite temperature and pressure sustained for a certain period of time, followed by a cold-water cooling period. The four systems shown herewith are flexible and, with only slight changes, could be used in any compression-molding press that incorporates a cure cycle, a cure and breathe cycle, or a cure, breathe and cooling cycle. In each of the four arrangements, the nucleus of the entire system around which all operations revolve is the actual die temperature.

Essentially, the interlocking control system was intended to:

1. Insure correct curing temperatures.
2. Insure correct cooling temperatures.
3. Insure constant molding conditions from cycle to cycle and thus provide quality control.
4. Provide for efficient use of all molding cycle time.[1]

* Gregory Blessing Associates.
** Instrumentation engineer, Brown Instrument Co.

[1] Many molders use the expensive process of employing an excess time cycle to insure complete cure thereby overcoming variations of temperature. In the control systems outlined herein, the cure cycle can be maintained at the minimum with assurance of uniform results.



DRAWING, COURTESY BROWN INSTRUMENT CO.

1—A schematic layout of control equipment intended for molding-press operation on an interlocking temperature-time basis in which both temperature and time are measured quantities. The reader is referred to footnote 3

5. Eliminate the human variable in critical compression molding operations.[2]
6. Provide a foolproof method of recording molding cycles for periods of operation when personal supervision is not present.
7. Provide an automatic record of breakdown time, die-cleaning time, etc.
8. Provide recording control instruments at a centralized position any reasonable distance from molding press.

The four systems described in the following paragraphs differ only in the type and cost of control equipment and in the degree of temperature control.[3] Systems 1 and 3 control only minimum temperatures of die and cooling water while Systems 2 and 4 provide for specific die-temperature heat through the use of a throttling valve on the incoming steam line and a cooling-water temperature control.

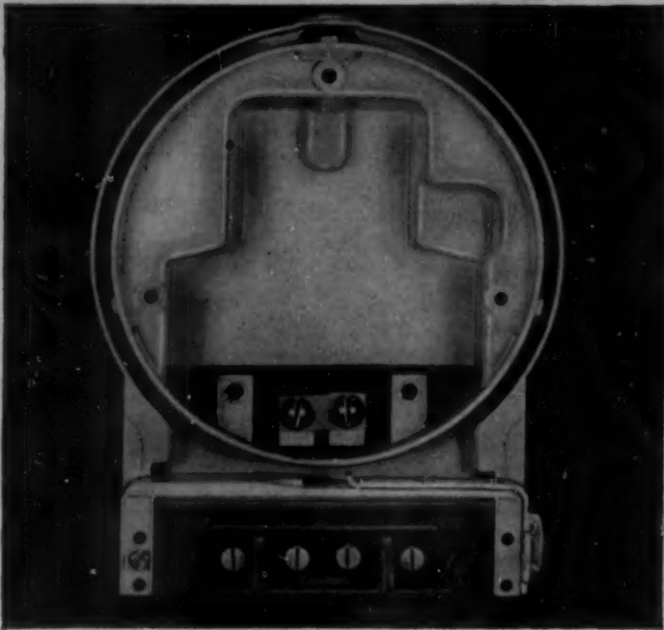
System No. 1—This system is intended for molding-press operation on an interlocking temperature-time basis in which both temperature and time are measured quantities. When the press is brought up to the desired temperature, a signal light indicates that the machine may be closed. A timer regulates the length of time the press remains closed, and the cooling water comes on automatically at the expiration of the predetermined molding time. When the platen temperature has been lowered sufficiently, the press opens automatically, the cooling water is shut off and the steam is turned on again to set the press for the next charge.

Figure 1 shows a schematic layout of equipment required to obtain the above sequence of operation. It employs an air-operated control thermometer with two control indices and one temperature pen. The control system on both indices are of the "on-off" type. One system is direct acting, that is, as the temperature increases the delivered air pressure increases. The other system is reverse acting, that is, the delivered air pressure decreases as the temperature increases. The bulb of the thermometer, 0.5 in. in diameter by 4 in. in length, is located in a hole drilled in the platen. The system also employs M.H. L404B pressuretrols and L456A temperature controllers—both of the non-indicating type.

One control index on the control thermometer is set to the temperature at which the press is to be closed; the other control index is set to the temperature at which the press is to be opened. The control indices are adjustable and can be set to any temperature on the chart. When the temperature is below the lower index, the No. 1 pressuretrol switch makes—pulling in relay No. 1 which energizes the 3-way, No. 1 solenoid and opens the 3-way valve to admit steam to the press. Because it is locked out through relay No. 2, the press remains open and cannot (*Please turn to page 178*)

[2] The unload and load cycle with the platens radiating in air is a variable induced by the operator, and is not controlled except by means of some type of system such as that outlined in this article. Recently in tests made on 4-lb. shots of a compression-molded part using electronic preheating techniques, it was found that the variation in mold temperature-recovery time was a definite factor in reducing or eliminating blisters. Because of a lack of a suitable control system, it was necessary to extend the "press open time" to offset this variation. This, of course, tends to counteract to some extent the beneficial effects of electronic preheating. Control systems, such as those described, will tend to increase the efficiency of an electronic preheating installation.

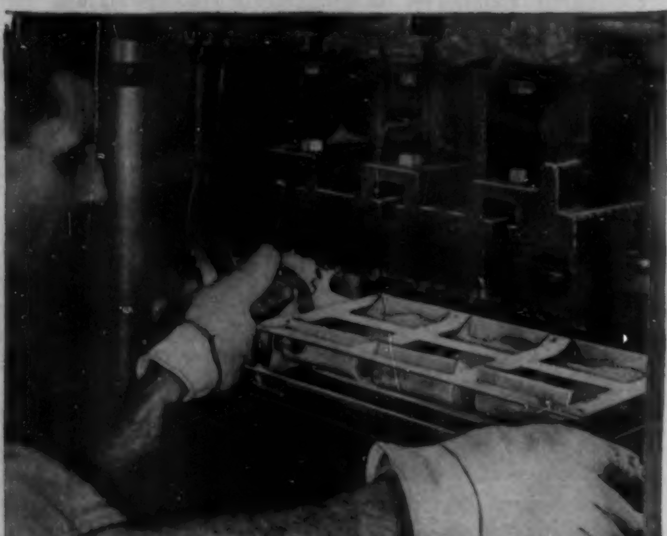
[3] Temperatures referred to and illustrated herein have been chosen arbitrarily merely for illustrative purposes. The control indices of the instruments described in this article can be set at any point throughout the total range of the instruments to fit the user's applications.



(*Above*) **TERMINAL BLOCKS OF MOLDED MELMAC** are installed in the die cast aluminum base of all Sangamo single phase two and three wire watthour meters to eliminate possibility of block failures resulting from arc tracking.

(*Above*) **MELMAC'S UNUSUAL ELECTRICAL PROPERTIES,** high arc resistance (A.S.T.M. Avge. 130 sec.), dielectric strength (430 Volts/Mil.), and heat resistance (300°F.) determined its choice for these Sangamo meters.

Life ON THE PLASTICS



(*Above*) **A 6-CAVITY DIE IS LOADED** with mineral-filled MELMAC molding compound ready to be molded into the filler-block for the Sangamo meter. MELMAC's strength, as well as electrical properties, are important in this use.

MELMAC 592 ADOPTED BY SANGAMO FOR ALL WATTHOUR METER TERMINAL BLOCKS

THE EXCEPTIONAL arc-tracking resistance of MELMAC* 592 has determined its selection by the Sangamo Electric Company for the insulation material to be used around the terminals in all single and polyphase watthour meters.

The installation of watthour meters in exposed locations subject to high voltage surges and lightning has increased the electrical stresses on the insulating materials used in their construction.

Extensive tests were made by the Sangamo Electric Company to find an insulating material with the right combination of properties in regard to strength and freedom from arc tracking. Cyanamid's mineral-filled MELMAC was found not only to eliminate the carbonization caused by arc-over but also to provide an atmosphere at elevated temperatures possessing arc-quenching properties.

During tests made in accordance with A. S. T. M. Standards, Cyanamid's MELMAC formaldehyde molding material showed an arc-tracking resistance in excess of 120 seconds (130 sec. average). Phenolic products, when measured by the same method, showed arc-tracking resistance rarely exceeding 5 or 10 sec.

The results of these tests demonstrated to the Sangamo Electric Company that the use of MELMAC would practically eliminate any terminal block failures which result from high-voltage surges or arc tracking. Therefore, MELMAC has now been adopted for use on all terminal blocks used in Sangamo watthour meters.

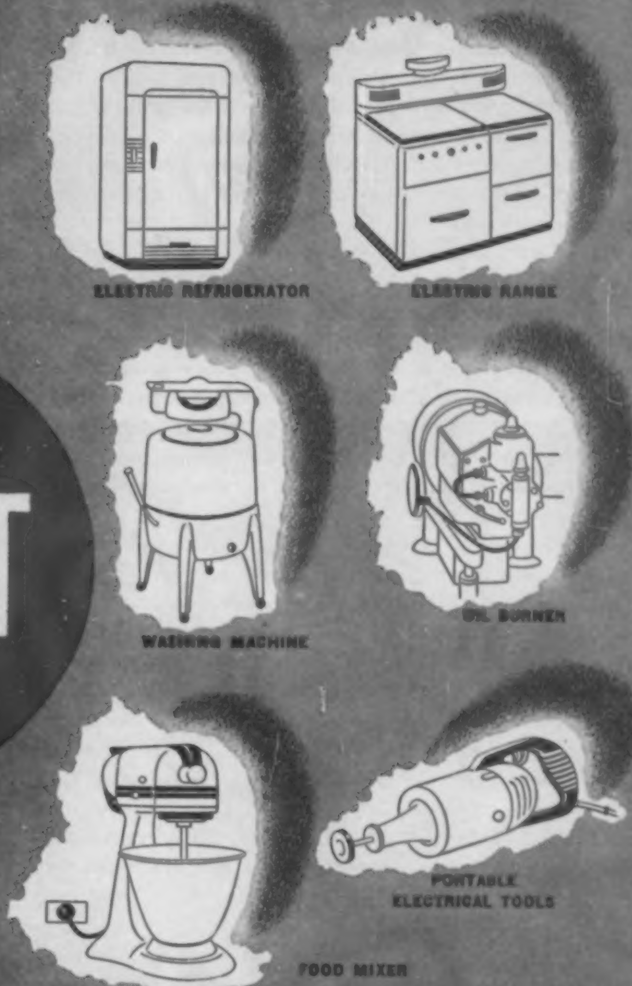
Reg. U. S. Pat. Off.

(*Above*) **THE "A" BLOCK** for the Sangamo terminal block is molded of MELMAC in a 4-cavity die. MELMAC's excellent insulating properties are maintained under all extremes of temperature and humidity.

NEWSFRONT

(*Above*) **MELMAC FILLER-BLOCK AND "A" BLOCK ARE ASSEMBLED** into the terminal block for installation in the die cast aluminum base of the Sangamo watthour house meter as shown above.

Cyanamid's mineral-filled MELMAC will find many new applications in electrical applications where arc-tracking resistance is of extreme importance. Its use in circuit breakers will make a major contribution to increased safety and service life. In switch plates, terminal blocks, connector plugs and other insulating parts for ranges, refrigerators, washing machines, power tools, which operate under varying conditions of dust, dirt, dampness and temperature, MELMAC's insulating properties, dielectric strength, heat resistance, and high arc resistance will also provide an added life and safety factor. Write for the manual, "MELMAC MOLDING COMPOUNDS".



AMERICAN CYANAMID COMPANY
PLASTICS DIVISION
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

CYANAMID PLASTICS

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Metallizing turret cylinders

by J. M. CRONE*

OUTSTANDING in this global conflict is the repeated "doing of the impossible." A case in point is the situation that arose when the research laboratory of the airplane division of Curtiss-Wright Corp. undertook the design and construction of a new airplane gun turret. One of the problems, unexpected and provoking, involved an attempt to assemble the plastic-metal cylinder which is a vital part of the fire interrupter for a .50-caliber machine gun mounted in the turret. This device prevents the turret gunner from firing into his own plane.

With a casualness born of the lack of complete information, company engineers took up the construction of this unusual plastic cylinder which has upon its convex surface a superimposed plastic pattern or profile of the airplane contour. The balance of the cylinder surface around the pattern is covered with a layer of silver not less than 0.015 in. thick. Specifications are such that after the deposition of this silver, the entire convex surface is machined and polished to an exact diameter with a working tolerance of +0.000 in., −0.002 inch.

The cylinders, approximately 8 in. long and 6 in. in diameter, are made up of a straight laminated plastic with a pattern of the same plastic material bonded to it covering about $^1/_4$ of its surface. The cylinder wall is $^3/_{16}$ in. thick, the pattern about 0.035 in. in thickness, and the silver deposited on the cylinder of approximately the same thickness as the pattern. When the part is complete and installed, an electric current of about 24 volts d.c., $^1/_8$ amp., supplied through a fast acting relay and solenoid, passes through the metal. The line of demarcation between the plastic and silver surface must be very sharp, to insure an accurate and complete make or break of the electric contact when an exploring point passes over it.

Electroplating

A start was made on the production of these plastic cylinders when an attempt was made to electroplate a group of ten cylinders, six of which were plated by a metal-plastic process. This process requires approximately one hour's immersion in a cold plating bath of silver nitrate and formaldehyde for each 0.001 in. of silver deposit. Since the cylinder must be machined to size after plating, a surface of over 0.030 in. in thickness was required—necessitating 30 hr. of immersion in the bath. In the case of five cylinders, the metal coating broke away from the plastic at one point or another, or the plastic cylinder became slightly elliptical so that it was impossible to machine the surface without cutting through the silver coat. Due in all probability to long immersion, the plastic pattern separated from the cylinder wall in some cases. One cylinder came out well enough for installation, but the line of demarcation between the plastic and silver was not entirely suitable.

Four more cylinders were plated by an ordinary plating process using a cold silver cyanide and potassium cyanide

* Engineer of design, Research Laboratory, Curtiss-Wright Corp.

1

ALL PHOTOS, COURTESY CURTISS-WRIGHT CORP.

bath. This method was entirely unsuccessful for any silver deposit beyond a thickness of 0.003 inch. Above that thickness the stresses set up in the metal on the convex surface seemed to be of sufficient strength to break away some of those portions of the metal which did not have continuity around the entire cylinder. When, in a few instances, the metal did bond to the plastic, later on as a result of machining, vibration or pounding, it loosened from the plastic at those points where there was only the plastic-to-metal bond.

At this point, a number of authorities on plating were consulted, and the consensus from past experience was that any metal deposited by electroplating process on a convex plastic surface under conditions similar to those described above, would fail in bond with the plastic if carried beyond the thickness of 0.003 inch. Few plating concerns showed any desire or inclination to do the type of plating described and none of the firms that were contacted from Long Island to Chicago would agree to do plating above 0.003 in. thickness on any other than an experimental basis. Up to a thickness of 0.002 in. the metal could be easily bonded to the convex plastic, but beyond the thickness of 0.003 in. the indications were that about one good piece would be turned out to ten imperfect articles. This excessive rate of rejection caused the company to turn to another method of applying a silver coat to the cylinders.

Sheet silver

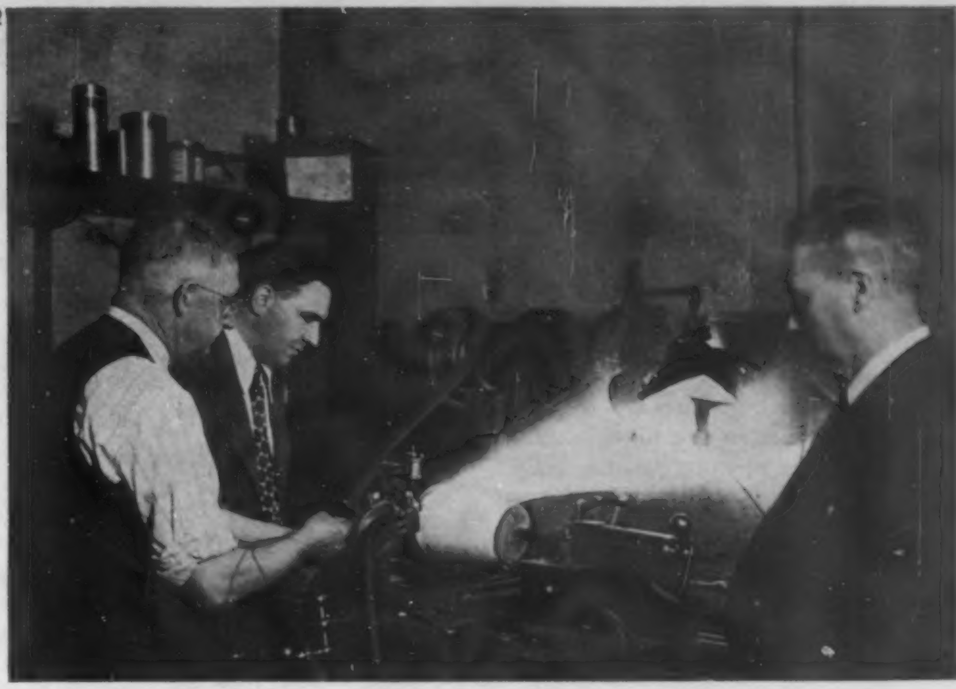
Next an attempt was made to put a 0.025 in. thick sheet of silver over the cylinder. This sheet was cut to fit the pattern on the cylinder, placed around the cylinder and silver-soldered at one side. It was impossible to shrink the thin silver cylinder onto the plastic because the pattern was raised above the plastic cylinder surface. In the case of two of the cylinders, two sheets were tried, but they were found to be loose in some spots and somewhat elliptical. Due to this eccentricity, machining of the cylinders was impossible. A bond between the silver sheet and plastic simply did not exist.

Spraying of molten silver

The spraying of a metal deposit was the next method used to plate the cylinders. The Metallizing Company was

1—The profile of the plane stands out clearly on this plastic cylinder which has been metallized with a coat of 0.015 in. silver and machined to size. 2—Here the silver is being sprayed on the cylinder. 3—Inspection of the surface of the nearly completed cylinder after the finish grind operation. 4—The cylinder is sand-blasted to remove grease, oil and various loose particles

2



given the assignment to coat two cylinders. In each case, once the cylinders were prepared, the metal application required only about one-half hour. However, although the cylinders were completely covered with silver, it was found that the coatings were not bonded to the plastic and worked loose on machining. All of the metal was easily and quickly removed. Part of the plastic surface was charred black by the heat of application, and much of the profile edge was burned and chipped. On the whole, the results were unsatisfactory and there was no indication that this process could be used with any success.

At the insistence of the superintendent of this company, a new cylinder was prepared upon which zinc was used as the coating metal in place of silver. Throughout the war the entire facilities of this shop have been devoted to the reclamation by metal spray of worn or undersized metal parts on all types of war materièl. Basing his opinion on past experience, Mr. Simon, president of the metallizing company, reasoned that if carbon steel, nickel, chrome steel, bronze and zinc can be bonded efficiently to other metals, there is no reason why the same metal or any other metal cannot be bonded to plastic. This reasoning prompted many experiments, more or less successful. Because of the pressing need for this cylinder in the turret development, every effort was made to discover whether this spray method was practicable. Every phase was considered. The application temperatures were recorded; air blast and water cooling were tried out; the hardness and type of deposit were noted; the porosity; the electrical conductivity and the practicability of application in production.

Mr. Simon, with a background of many successful years in electrical construction, thought of trying an electrical degumming experiment to prepare the plastic to bond with metal, not merely become coated with metal. This was it! From Saturday night until Monday morning metal was sprayed on wood, leather, paper and plastic—anything. It held—it was bonded. On Monday, the cylinder was sprayed with zinc. The bond was apparently perfect. The cylinder was machined, ground and polished. To date, the part is a perfectly bonded example of how molten zinc can be deposited on plastic. (*Please turn to page 192*)

3

4

A guide for the buyer of molded parts

WHILE a great deal has been written regarding ways and means of purchasing better quality merchandise at cheaper prices, not too much buying information has been made available to the average purchaser of molded plastics. This article is not directed at the purchasing departments of such firms as Chevrolet, Radio Corporation of America or American Safety Razor. Companies of this size have already purchased millions of dollars worth of plastic parts. In so doing, through the process of trial and error, they have arrived at a proper method for developing the price which should be paid for whatever part they wish to purchase, and at ways and means for deciding which molder or molders should be given the job. In many cases, more than one source of supply is necessary, due either to the large quantity of production required over a specified period of time or to company policy. One of the reasons for company policy dictating more than one source of supply is that any interruption in production of the plastics parts might well interrupt production of an entire assembly line and, in such an event, be far more costly than the comparatively slight additional cost of another set of tools. This knowledge of plastics purchasing is limited, however, to the larger manufacturers.

Four costs involved in plastic production

Buying information for the average plastics purchaser for whom this article is intended must begin with a consideration of the elements necessary to produce a molded part. The first of these is a complete working drawing of the part itself and, second, a scale model which enables all interested parties to see the finished part before final approval is given and work begins. The parts drawing forms the basis for mold drawings from which the mold is constructed. After the mold is made, material is purchased and the part is molded. Then follow the various finishing operations usually necessary to bring a part to its final stage. Thus, four separate costs are involved in the production of any item:

1. The cost of engineering the part and producing the mold for the part.
2. The cost of the material for the molded part.
3. The cost of molding the part.
4. The cost of the final finishing and inspection operations.

As requirements for a specified molded part are changed, there will be variations in certain of the four contributing cost factors. The cost of the mold can vary as can the cost of the molding. But once a specific material is decided upon, very little variation will be encountered. To a great extent, the same fixed-price condition applies to the finishing operations. Thus, there are two variable and two fixed items of cost.

For the moment, attention will be focused upon the effect of the two variable items—mold cost and molding cost—on the final cost of the molded part. If a very small production is required, it will not be necessary to build a mold larger than one cavity. For this reason, the tool cost will be comparatively low. However, by the same token, the molding cost per piece will be very high. If a mold with more cavities is built, the mold cost will, of course, be increased while the cost of molding will be correspondingly reduced since more pieces are molded during each cycle. A decision must be made that will balance satisfactorily the number of cavities to be built in the mold against the required mold cost, piece-price and daily production—elements governed by the mold size.

While arbitrary examples are not exactly accurate, they serve to illustrate the problem. With a single-cavity mold, but one piece is made each time the mold operates and ap-

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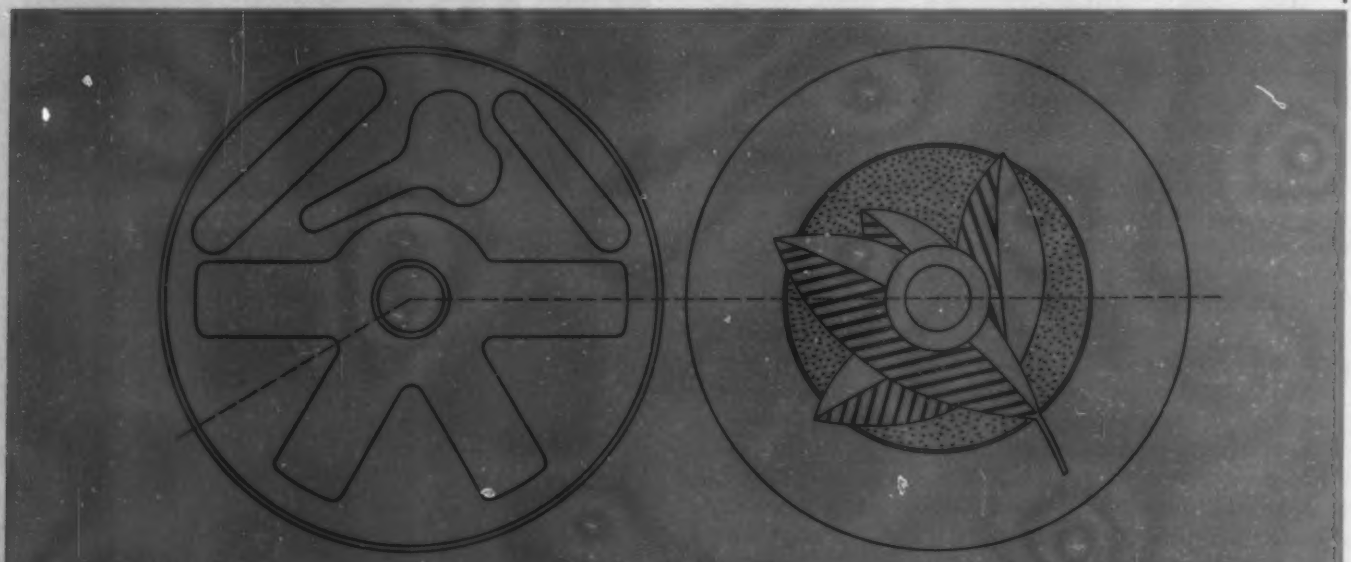
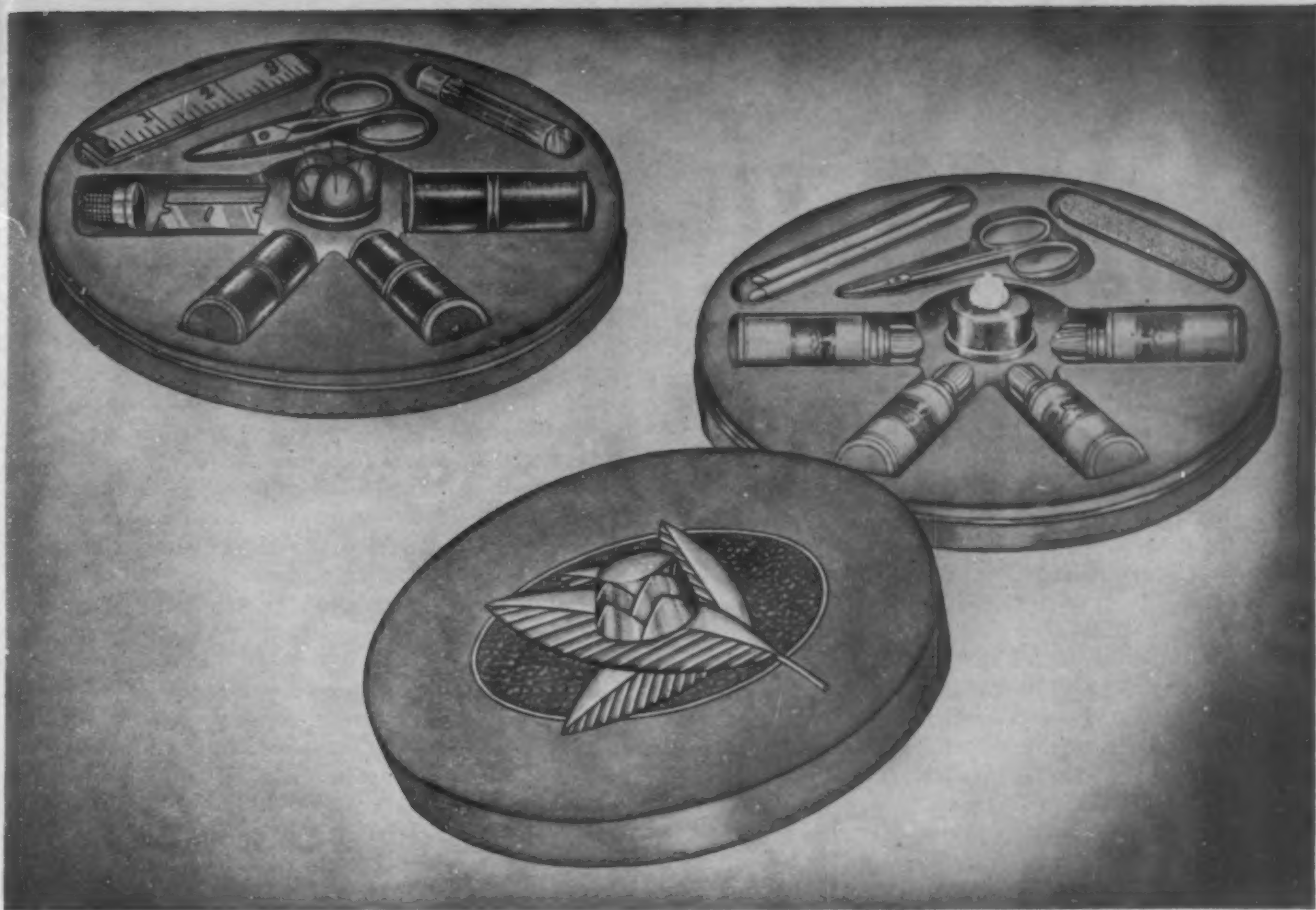




2

BOX DESIGNED BY JEAN REINECKE. RENDERING BY MODERN PLASTICS ART STAFF

1—A working drawing of a design which might have been submitted by any reputable molder. 2—This box, intended primarily as a container for manicure preparations, is so designed that it can find subsequent use as a sewing basket

proximately 10 pieces can be made from the mold during each hour of operation. Therefore, it takes 100 working hours to make 1000 pieces. If the mold had been designed with 10 cavities, making 10 pieces each time it was operated, approximately 100 pieces could be made each hour and only 10 hours would be consumed in molding the required production of one thousand. This would permit a saving of 90 hours of labor.

If the entire production required from these molds was definitely known to be only 1000 pieces, the problem would be very simple. It would merely be necessary to multiply the piece price from the single-cavity mold by 1000 pieces, add the cost of a single-cavity mold, and compare the total thus obtained with the piece price from the 10-cavity mold (lower, of course, than from the single-cavity mold) to which the higher mold cost has been added. An order would then be placed for the cheaper method of producing the parts. The difficulty is that actual cost problems are not nearly as simple as this example. Seldom can a purchaser be sure he will need only 1000, or 10,000, or even 100,000 parts.

For this reason, the problem of deciding just what size mold to build calls not only for arithmetic but also for some good foresight and "guesstimating." Sometimes it is advisable to consider nothing but a single-cavity mold until the market for the piece has been definitely determined or until the new article is finally developed and there is no further question as to its final size, shape or design. If, after trial, the original idea proves to be absolutely correct and the market is firmly established, the single-cavity mold can be replaced by a mold of larger capacity. In some cases the single-cavity mold can be incorporated in the larger tool.

Figure 3 is a curve, drawn up using arbitrary figures, which in the light of past experience appears to be a fair example of piece price versus tool cost for a run-of-mine compression-molded job such as the top or bottom of a box or a rectangular block. This curve, although arbitrary, does indicate one surprising fact—that the total cost, made up of the mold cost and the piece cost, for a quantity of 25,000 pieces is lowest for a 4-cavity mold. Not until production requirements approximate 100,000 pieces is the increased cost of larger production molds absorbed so that the larger number of cavities make themselves felt in a lower composite price.

It is, of course, very simple to state arbitrarily that your market will require a total production of 50,000 pieces or 500,000, but it takes a very smart operator to gage his total sales accurately. Consequently, allowance must be made for possible error. It is suggested that a good rule to follow is to place emphasis upon the lower piece price rather than the lower mold cost. Once the mold—that is, a multiple-cavity production mold—is built and operating, it is a very difficult and costly matter to increase its capacity and thereby reduce the piece price. The mold cost should be looked upon as capital expense, and the purchaser of plastics should bend over backward to purchase not only a somewhat larger mold than is dictated by his required production but also a well-designed mold which is built by experienced toolmakers.

Variations in price quotations

When requests for prices are made to more than one molder, there is every reason to believe there will be some variation in the quoted figures. Many purchasers of plastics have re-

ceived a very bad impression of the plastics industry when they received widely varying quotations—with, perhaps, one molder quoting a price as much as three times in excess of that submitted by another molder. When the Armed Services first began to purchase plastics and bids were available to the public, some astounding figures came to light. Of course, these price variations reflected, in some cases, the ignorance of the bidders. But, more often, they reflected the ignorance of the purchasing division of the particular branch of the Armed Services involved.

When any item of information with reference to a molded part is not available to the estimator of a plastics molder, this estimator, in order to protect himself and his company from loss, may conclude that the part should be made in the most expensive manner and of the most expensive material possible. Another estimator may take just the opposite view. He may decide that the part can be made in a cheaper manner than is actually desired by the purchaser and, therefore, quote a proportionately lower price. This simply demonstrates one of the reasons for wide variations in quotations on plastic parts. It can be argued, of course, that each estimator should specifically state the fact that certain information was missing and that his particular price was predicated upon a certain method of manufacture or a certain material. However, this is oftentimes not done and, as a result, misunderstandings often develop. Therefore, several simple rules should be followed which will eliminate all such problems.

Before requesting a price from a group of molders, the prospective buyer should provide the following information:

1. *Tolerances*—The buyer should make ready a working drawing of his molded part, complete with dimensions, all of which should be controlled by specific tolerances. These tolerances should have been given some careful thought and not been placed arbitrarily upon their dependent dimensions. If a mechanical pencil barrel were about to be molded, the inside or working dimensions would be of the utmost importance. Therefore, fairly close tolerances would be required. On the other hand, the outside dimensions of the barrel, be it round, hexagonal or octagonal, would have little bearing on the operation of the pencil. Many engineers have made the mistake of putting unnecessarily close tolerances on such unimportant dimensions, and their employers have paid unnecessarily high prices for the product.

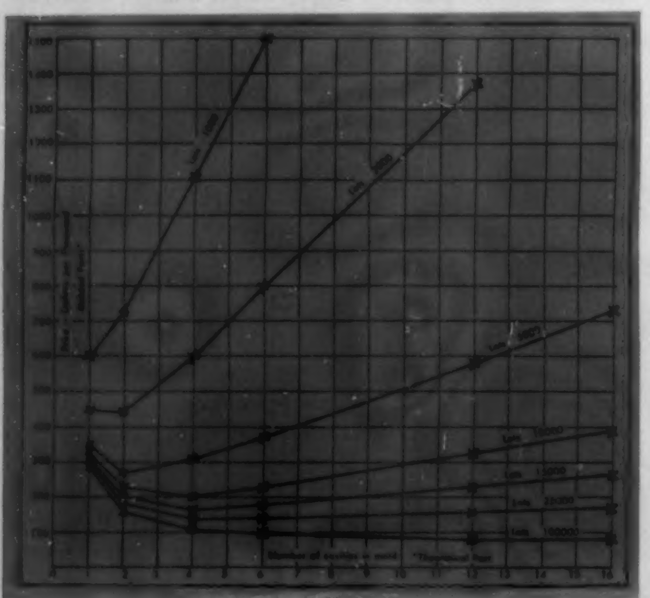
2. *Specifications*—The prospective purchaser should also submit a complete set of specifications for his product. These specifications should include the complete description of the end use of the article together with any pertinent data which will have an effect upon the material finally selected—points such as the maximum and minimum temperatures which the material will be required to withstand. Will acids or alkali be liable to come in contact with the part? Just how strong must this piece be? Must it withstand heavy shock loads? Is the color of importance and, if so, is it to be a pastel shade or will darker colors be satisfactory? Is it necessary that all flash lines be carefully finished and buffed so that the flash line is no longer visible, or can some of the parting lines merely have the flash removed without additional finishing? Just what finish is necessary on the balance of the part? Must it have a high luster or will the molding finish be satisfactory? If any lettering is to be included, must this lettering be raised or depressed? Are the letters to be molded in, engraved or stamped afterward?

The above are but a few of the elements which must be taken into consideration, and they should be included in all part specifications that are submitted for price quotation. A study of pages 318 to 325 in the PLASTICS CATALOG is recommended for a complete coverage of such information. While it is possible to specify the exact material to be used in a specific piece, giving the manufacturer's material number and flow, it is suggested that the specifications also include the term "or equal." In this way, there will be no question of a possible bidder quoting a higher price due to some particular prejudice he may have against the particular company's material so specified.

3. *Working model*—If a sizable production is anticipated, it is always wise to have a complete working model constructed. This model should duplicate as nearly as possible the proposed molded part. The same wall sections as are specified on the drawing should be incorporated in this model, and any hardware or assembly devices should be included thereon. This model should be available to all prospective bidders so that any question can be definitely settled by a close inspection of the model, generally at the buyer's own office. This contact leads not only to a perfect understanding of the drawing, but also to closer and more intimate relations between buyer and prospective seller.

One of the greatest injustices with which the plastics industry has had to contend is the buyer who requests prices on very high quantities and then attempts to purchase a much smaller quantity at the larger-quantity price. Prospective buyers who anticipate purchasing any quantity of plastics are warned against acquiring the reputation of being a buyer of this type. Once a molder has been burned by these tactics, all his future prices to the particular buyer under question will directly reflect the suspicion in his mind that the buyer will again attempt to purchase a small quantity at a high-quantity price.

3—Based upon past experience, this curve which was drawn up using arbitrary figures appears to be a fairly accurate guide to piece price versus tool cost for average compression-molded jobs such as the top of a box



Summary

In summing up, it is well to point out that when a group of bids are requested from any healthy industry, some variation in quoted price is to be expected. This is only natural. There is, however, one red light of caution. The temptation exists for a purchaser to place an (*Please turn to page 182*)

nite steering wheel for landing craft molded by American Hard Rubber Company

The Helm of Invasion Craft

• Tenite wheels steer landing barges to the beachheads. They were at Anzio, Normandy, and Saipan.

Years ago, Tenite proved itself the ideal material for this important part in landing operations. Tenite was the most widely used plastic material for automobiles and speed boat steering wheels. And the same features which made it popular in peacetime—extreme toughness, weather resistance, pleasant feel, and speed of molding—also made it first choice for steering wheels of jeeps, Army trucks, and airplanes.

If your post-war product requires controls or handles—unbreakable, colorful, clean, and pleasant to the touch in either hot or cold weather—investigate the possibilities of molding them of Tenite. Write TENNESSEE EASTMAN CORPORATION (Subsidiary of Eastman Kodak Co.), KINGSPORT, TENNESSEE.

TENITE REPRESENTATIVES . . . *New York,* 10 East 40th Street. *Buffalo,* 1508 Rand Building. *Chicago,* 1564 Builders' Building. *Dayton, Ohio,* 305 Third National Building. *Detroit,* 904-5 Stephenson Building. *Leominster, Mass.,* 39 Main Street. *Washington, D. C.,* 1125 Earle Building . . . *Pacific Coast:* Wilson & Geo. Meyer & Company—*San Francisco,* 333 Montgomery St., *Los Angeles,* 402 Architects Building, *Seattle,* 1020 4th Ave. S.

TENITE

AN EASTMAN PLASTIC

Structural composite plastic materials

by H. C. ENGEL and W. W. TROXELL*

BECAUSE of its need for light materials, the aircraft industry has exhibited considerable interest in developments in the plastics field. An infinite number of nonstructural plastic items are currently employed in aircraft, but structural plastics are, for the most part, still of academic interest. Primarily, conventional plastic materials have been found inadequate for aircraft structures because of their lack of stiffness.

The advantages of a material composed of stiff, dense faces separated and stabilized by a thick, light core, have long been apparent. This concept is merely an extension of the well-known practice of separating structural sheeting by means of a central corrugation. In the aircraft industry, considerable interest has been stimulated in sandwich materials by the ever-increasing difficulty of maintaining rigid contours in high-speed aircraft. More and more, aircraft designs are based upon allowable deflections rather than upon strength considerations alone.

Sandwich materials, because of their superior stiffness-weight characteristics, lend themselves to simplified structural designs and allow production of very economical units. The entrance hatch door for a medium bomber (Figs. 1 and 2)

* Design engineer in charge of Structural Plastics Development, and design engineer in charge of Structural Development Group, respectively, The Glenn L. Martin Co.

1 and 2—Front and side views of an entrance hatch door for a medium bomber. This door is a typical semi-structural aircraft part which can be fabricated from sandwich material at a minimum cost and with minimum weight

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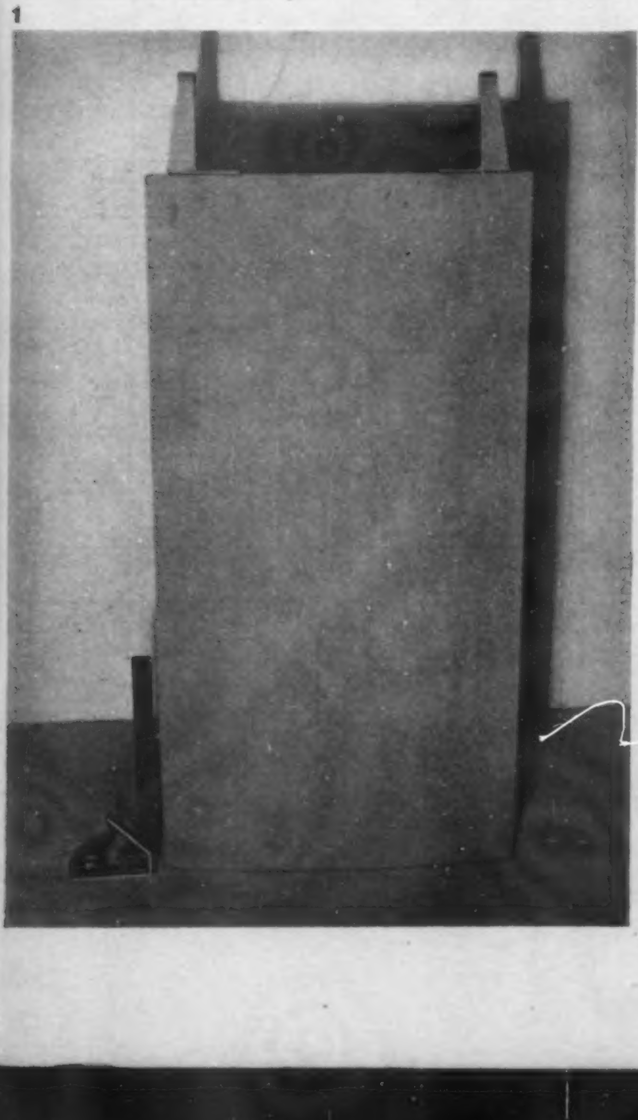

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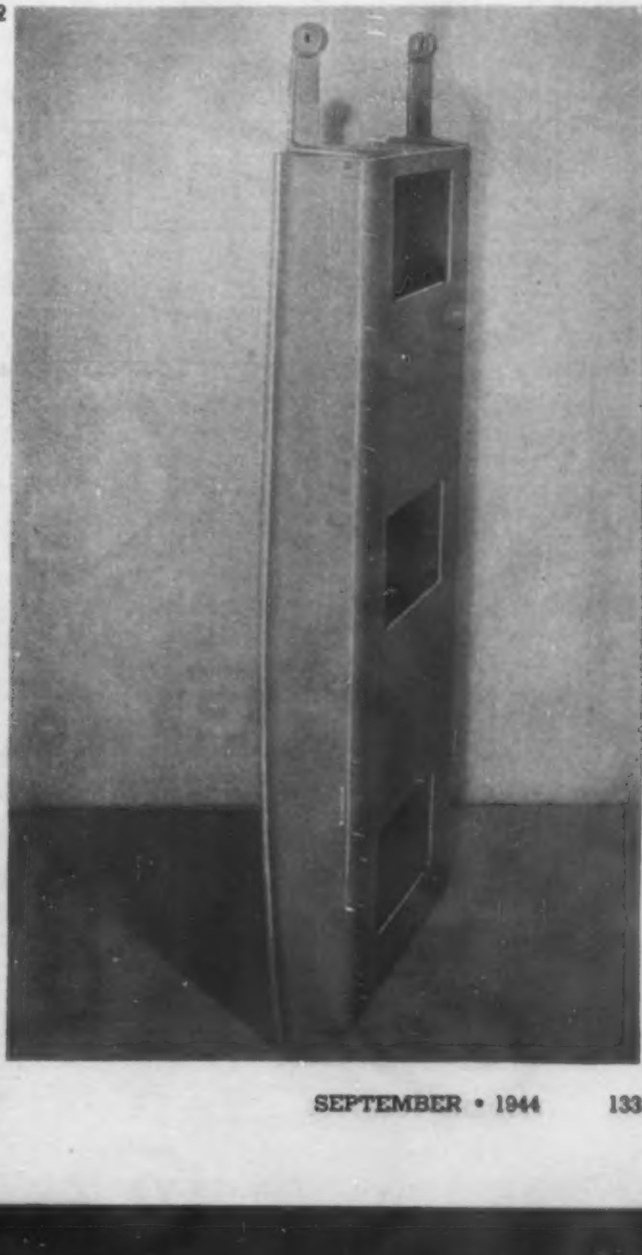

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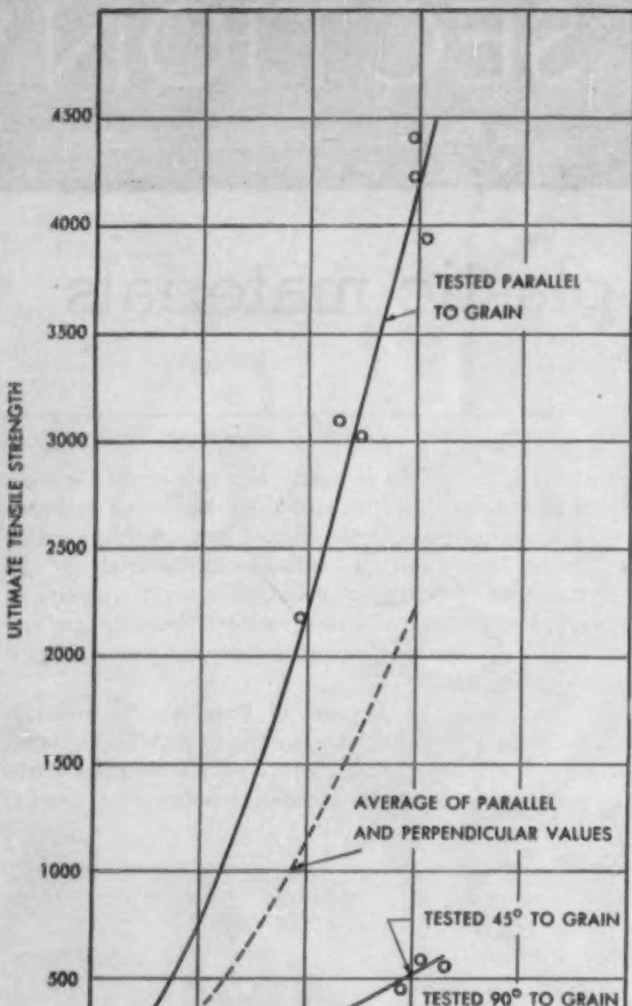

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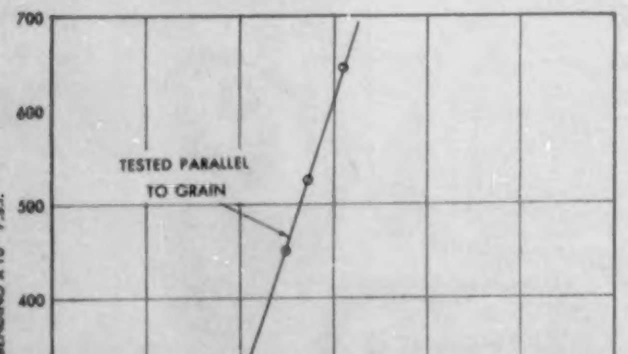

is a typical semi-structural aircraft part which can be fabricated from a sandwich material at a minimum cost and with a minimum of weight. The particular unit shown in the two illustrations passed required static tests when constructed of a high-strength paper-faced sandwich material which had a specific gravity of 0.60.

Basically, the requirements for a suitable sandwich material are very simple. It must be light, very stiff, relatively strong, and capable of economical fabrication into useful structural units. Ideally, any sandwich material should be isotropic in character. A variety of useful face materials are commercially available. Among them are aluminum and magnesium alloys, plywood, and resin-impregnated paper, fabric, glass cloth and wood veneer. Considerable effort has been directed toward the development of a light and sufficiently strong core material, but no entirely suitable product is as yet commercially available, although a number of promising materials are known. The lighter species of wood, especially balsa, have been employed in sandwich structures with some success. The difficulty of procuring uniform material and certain obvious disadvantages in fabrication methods tend to limit the usefulness of these light woods. However, the excellence of their physical strength characteristics, particularly in the grain direction, is noteworthy.

Because balsa wood has been employed successfully as a stabilizing medium in sandwich construction, its physical properties are of considerable interest. They are especially useful as comparison criteria for the various porous substances proposed as core materials. In Figs. 3 to 7 the variations of several basic physical properties with the specific gravity of the specimen are indicated. Because of the limited number of specimens tested, the relations shown should be looked

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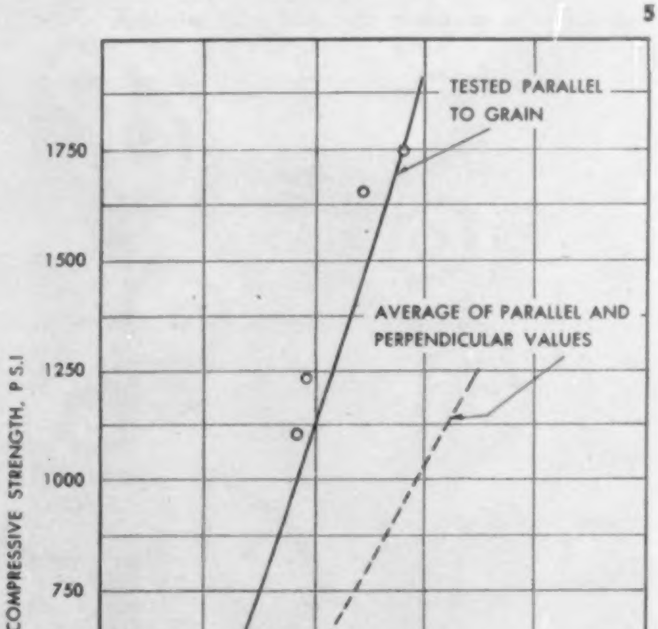

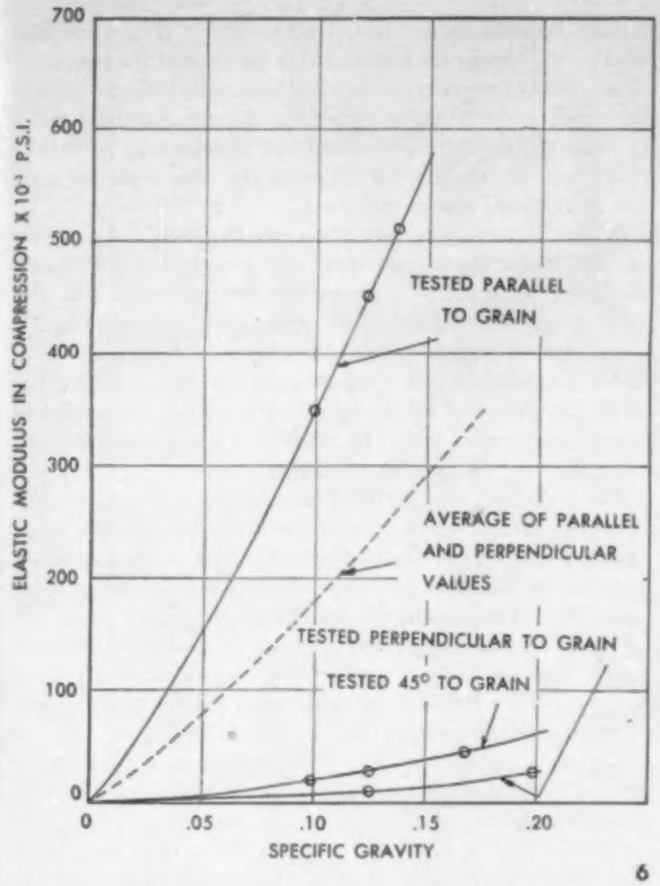

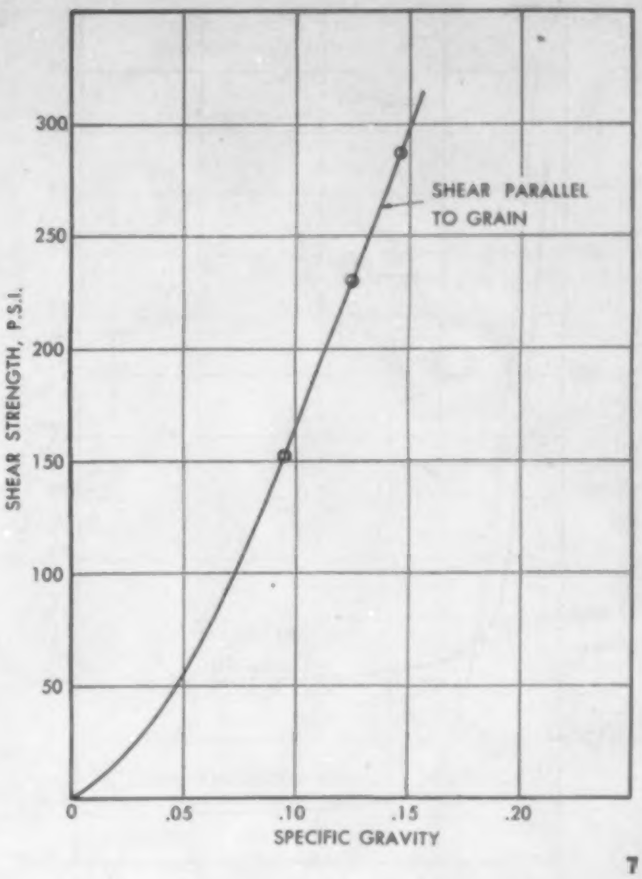

3—Tensile strength vs. specific gravity (for a limited number of balsa specimens at 4.0 percent moisture content). 4—Bending modulus vs. specific gravity (for a limited number of balsa specimens at 4.0 percent moisture content). 5—Ultimate compressive strength vs. specific gravity. 6—Compressive modulus vs. specific gravity (for a limited number of balsa specimens at 4.0 percent moisture content). 7—Shear strength vs. specific gravity

upon as being somewhat approximate. The data also indicate the variation of properties with grain direction. Dotted lines have been drawn to illustrate average values for tests parallel and perpendicular to the grain. Isotropic balsa substitutes might logically be compared with strength values obtained from these "average" curves.

Resinous core materials

A wide variety of synthetic substances have been investigated as possible raw materials for the production of porous stabilizing media. Expanded ebonite was one of the first materials of this type. Phenol-formaldehyde and urea-formaldehyde resins, polystyrene, polyvinyl chloride, polyvinyl formal, cellulose acetate and several of the so-called "allyl" thermosetting resins have been expanded into porous structures by various methods. Widely different physical properties have been obtained—frequently with the same resin and at a single density.

Apparent density and the type of structure determine the properties of an expanded plastic. Closed cells produce the highest strengths and, of course, the best water resistance. For example, in a certain type of porous phenol-formaldehyde resin the cell size distribution was found to play an important role in determining the physical properties (Fig. 8).

The relationship existing between physical characteristics and specific gravity for porous materials is of considerable interest. In Fig. 9, the ultimate compressive strength, modulus of rigidity and elastic modulus in bending for a phenol-formaldehyde material are plotted as ordinates against specific gravities as abscissas. The steep slopes of the curves of Fig. 9 illustrate clearly the loss in physical properties caused by reduction of density. Table I contains strength-weight data for a dense, unfilled, molded phenolic resin and for expanded resins having densities of 0.1 and 0.3, respectively.

TABLE I.—STRENGTH-WEIGHT RATIOS FOR COMPRESSED AND EXPANDED PHENOLIC RESINS[a]

Property	Compressed resin	Expanded resin	Expanded resin
Specific gravity	1.3	0.30	0.10
Specific compressive strength, p.s.i.	15,000	4340	1400
Specific flexural strength, p.s.i.	12,000	1600	1000
Specific bending modulus, p.s.i.	0.77×10^6	0.2×10^6	0.1×10^6

[a] Specific strength values are calculated by dividing the values for these properties by the specific gravity of the material.

Pulp-base core

Another core material that differs from those previously discussed in that it contains a fibrous filler, is one composed of approximately equal proportions by weight of resin and either wood pulp or other cellulosic filler. While possessing somewhat higher moisture susceptibility under immersion conditions, it is, in general, otherwise superior in physical properties to the previously mentioned porous materials. Its principal advantages lie in its low cost, in the ease with which

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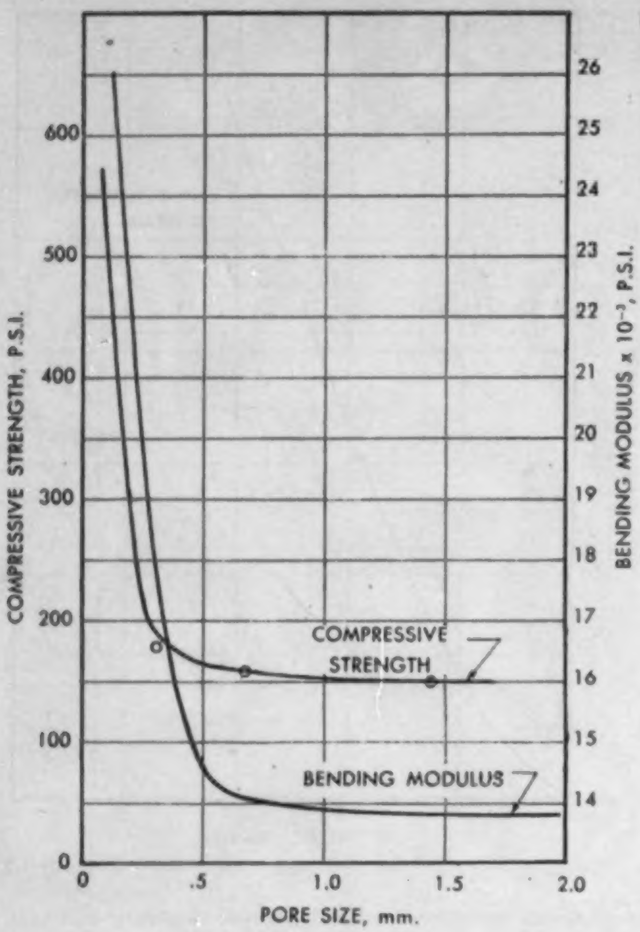

it may be manufactured, and in its many fabrication advantages. Among the latter may be mentioned the ease with which ribs or stiffeners can be attached to the material during the molding operation, the simplicity of increasing the density in localized areas where concentrated stresses may be anticipated, and the readiness with which the cross-sectional area can be increased wherever desired.

While the average density of the core material is intended to be low, it can be increased wherever necessary for design purposes—as at areas of rib or stringer attachment—by the very simple expedient of adding extra material and reducing these areas of increased weight to the same thickness as that in the surrounding area. Where only increased section is desired, the area of added material may or may not be varied in density, depending upon the amount of compression accomplished during the molding operation.

The pulp-base core material may be prepared in a variety of ways—each of which possesses advantages and disadvantages. Regardless of the method employed, several common features are necessary for the production of light, strong, porous cores. The most important of these details are 1) the use of relatively stiff, coarse, paper-making fibers to impart bulk to the product, and 2) the incorporation of relatively large amounts of a suitable resinous material to give good binding action under low-pressure molding conditions.

The resin and filler may be combined before or after formation of a board or preform of some specific shape. Conventional board forming machines, such as the Oliver or Fourdrinier types, may be employed to produce the core material in sheet form, or foraminous dies may be utilized to allow the approximation of a definite curved surface. The binding substance, when added before the operation in which the core is

8—Effect of pore size on properties of expanded phenol-formaldehyde resin. 9—Properties of expanded phenol-formaldehyde resin. 10—Tensile and flexural strength vs. specific gravity for fiber-resin cores. 11—Elastic constants vs. specific gravity for fiber-resin core. 12—Stiffness-weight criterion as a function of percent of core

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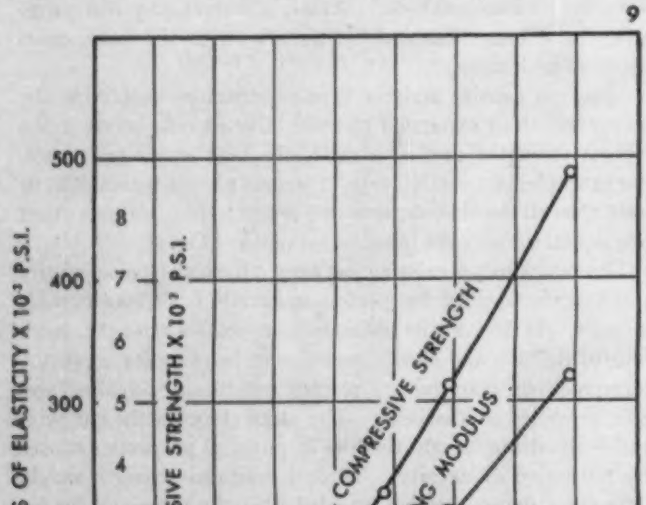

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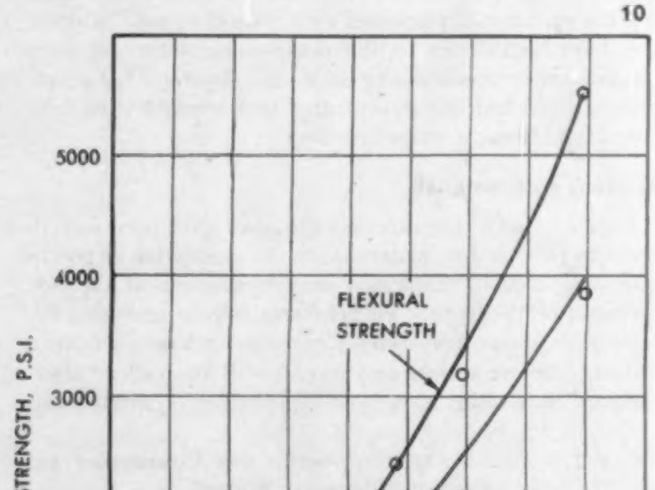

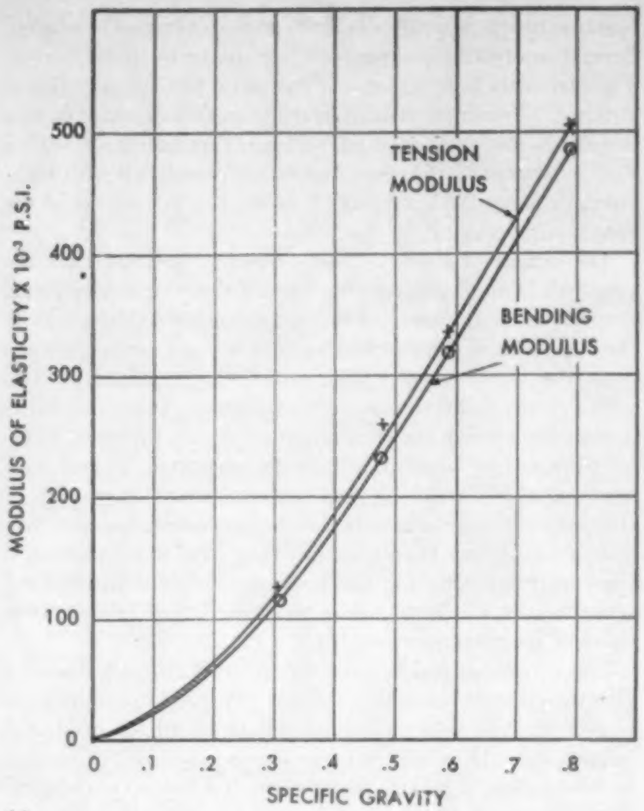

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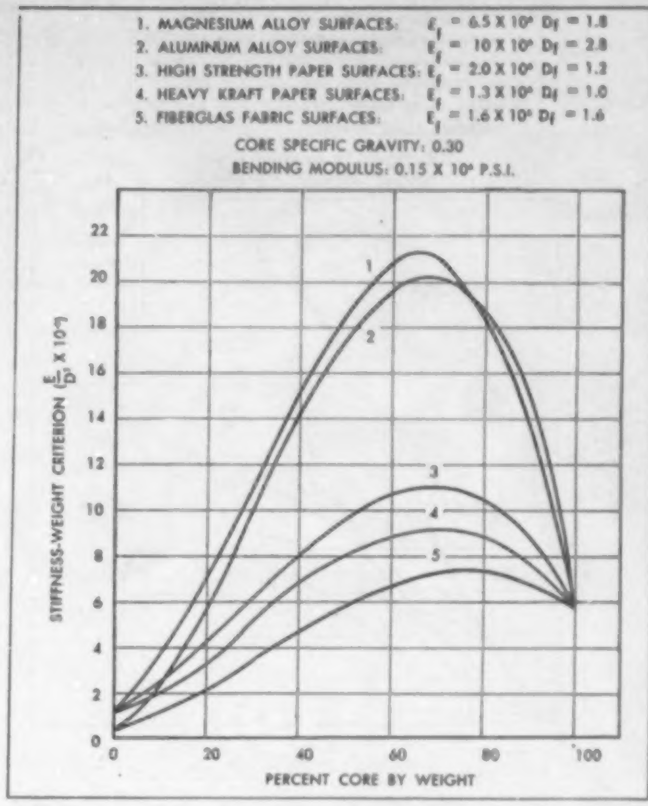

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formed, may be added as either a water insoluble powder, a water soluble solution or water emulsion from which the binder may be precipitated. If the fibrous core is formed first, the introduction of the desired amount of resin in a subsequent operation is more difficult, because of the tendency of the resin to migrate during the drying of the core. Unless very special drying methods are employed, such a material tends to have a low resin content at its center.

The core may be molded into the desired shape and completely cured before the surfaces are bonded to it, or the assembly of the three components of the sandwich may be accomplished during molding. The first procedure allows the use of relatively high pressures; the second procedure prohibits high pressures. Molding is generally conducted so as to allow accurate control of the thickness of the sandwich. Rigid dies are preferable. These are closed during molding to a predetermined clearance which corresponds to the proper thickness and density of the sandwich. Ribs, stiffeners, reinforced areas, inserts, etc., are all incorporated in the structural unit during molding. Fluid pressure molding methods can be used but generally are not feasible where density variation is necessary or where rigid control of thickness is required. Relatively imperfect molding dies are quite satisfactory for the fabrication of the pulp-base sandwich materials. Because of the nature of the strength-density ratios for these materials, variations in die dimensions which give rise to density variations do not seriously affect the structural nature of the molded unit.

Some physical properties of a fiber-resin core composed of 50 percent resin and 50 percent fibrous material and molded to various densities are shown in Figs. 10 and 11. The ideal stabilizing medium should possess a very low apparent density (less than 0.10). However, because of the low shear strength of materials in this density range, practical work with sandwich materials having pulp-base cores has been confined to cores whose densities exceeded 0.30. At this density good all-round properties may be depended upon and reliable performance of the material anticipated. Future developments may lead to suitable lighter core materials which can be produced and used under practical conditions.

Flexural characteristics of sandwich boards

In a composite sandwich-type board—formed of a low-density core material between the faces of high-density, high-strength material—the structural properties depend on the ratio of the core thickness to the thickness of the face material. As the face thickness is increased, the board becomes stronger and stiffer, but also heavier. There is a certain core-thickness ratio which will give the maximum flexural strength-weight ratio, and another which will give the maximum flexural stiffness-weight ratio.

On the other hand, the best tensile characteristics will be obtained by using the high-strength material alone. This is because the addition of low-strength core material adds to the weight without commensurate increase in tensile strength. The sandwich-type board thus finds its best application in those structural parts which must resist compressive and lateral loads, where flexural stiffness and strength are of primary importance. With two materials of the proper characteristics, it is possible to construct a composite board which will have, for a given weight, flexural stiffness and strength several times greater than that possessed by either of the two materials when used alone.

The flexural stiffness of a strip of material is directly proportional to its modulus of elasticity and the cube of its thickness. For two strips of equal weight per unit area but of different materials, the thickness will be inversely proportional to the specific gravities of the materials. Hence for boards of given weight, width and span, the flexural stiffness will be proportional to E/D^3, where D is the average specific gravity. The quantity E/D^3 may therefore be used as a convenient criterion of flexural stiffness for boards of equal weight.

Figures 12 and 13 show the stiffness-weight criterion as a

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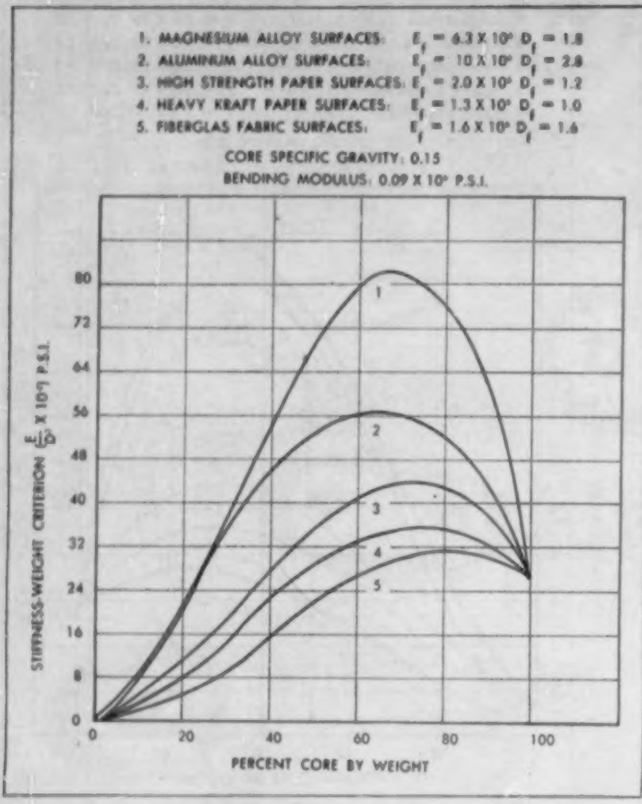

13—*Stiffness-weight criterion as a function of percent of core.* 14—*Optimum* $\frac{E}{D^3}$ *values vs. the specific gravity of core*

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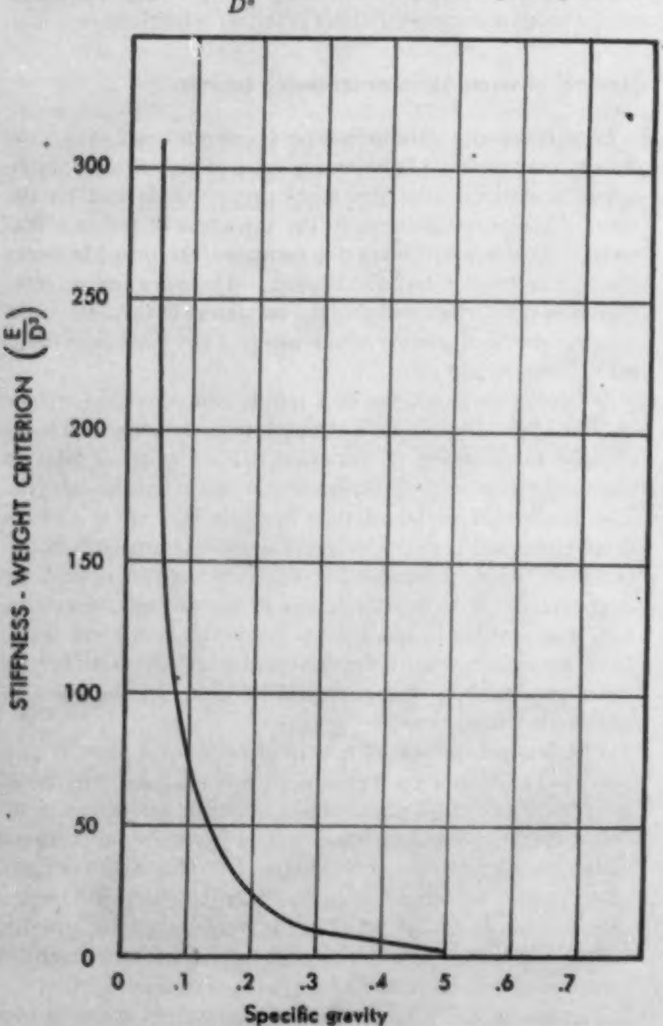

function of the percent of core for various types of sandwich. Several interesting comparisons are shown by these curves. The extremely high stiffness of the metal face construction is striking. The improvement in stiffness with decrease in core density is also very marked. This is further illustrated by Fig. 14 where the stiffness criterion of a sandwich with high-strength paper-laminate faces is plotted as a function of the core specific gravity.

The curves of Figs. 12 and 13 clearly indicate that the sandwich is more efficient, from a stiffness-weight viewpoint, than either of the two constituent materials. The peaks of the curves show the maximum stiffness that can be obtained from the combination. The value of core-thickness ratio which gives this maximum is the optimum. Figure 15 shows a chart from which the optimum ratio of core thickness to total thickness of board to obtain the maximum flexural stiffness-weight ratio can be read directly when the moduli of elasticity and specific gravities of the two materials are known. It can be shown that for relatively light core materials, the construction having the greatest flexural stiffness for a given weight will have a core weighing approximately two-thirds of the total board weight.

The core ratio which gives the greatest stiffness does not give the greatest strength. Curves giving the optimum ratio of core thickness to total thickness of board for maximum flexural strength-weight ratio are shown in Fig. 16. Comparison with Fig. 15 reveals that for greatest strength, the core-thickness ratio should be somewhat less than that selected when the greatest stiffness is desired. In most cases a compromise value would probably be best, because changing the core ratio slightly from the exact mathematical optimum reduces the stiffness or strength criterion very little. This can be seen from the curves of Figs. 15 and 16.

So far, in order to develop in as simple a fashion as possible some of the fundamental properties of the sandwich type of construction, the discussion has been of pure flexure. However, cases of pure flexure are seldom encountered in design. In all practical problems, shearing forces are present. Also in compression members, shear stiffness plays a role similar to that of flexural stiffness but to a varying degree—depending on the length of the member. In very long columns or in laterally loaded plates of long span, the shear stiffness is a negligible factor but in very short members it may play a dominant role.

The effect of shearing strains on deflections can be taken into account by using an effective flexural modulus, denoted by E_b, in place of the flexural modulus for bending (E). The relationship between E_b and E is:

$$E_b = \frac{E}{1 + c\dfrac{(t)^2}{L}}$$

Table II.—Apparent Bending Modulus at Different Span Lengths for a Composite Plastic

(*Sandwich board having high-strength paper-laminate faces and fiber-resin core.* $t_c/t = 0.79$, $t = 0.25$ *in.*)

Length of span	*Calculated bending modulus* $\times 10^{-6}$
in.	*p.s.i.*
18	1.35
15	1.32
10	1.29
6	1.12
4	1.04
2	0.63

Table III.—Physical Properties of Sandwich Materials

Material	Specific gravity	Core thickness / Total thickness	Core Percent of total weight	Ultimate tensile strength / Specific gravity	Tensile modulus / Specific gravity $\times 10^{-6}$	Modulus of rigidity[a] / Specific gravity	Bending modulus / Specific gravity $\times 10^{-6}$	Stiffness-weight criterion $\frac{E}{D^3}$ $\times 10^{-6}$	Shear modulus / Bending modulus
				p.s.i.	*p.s.i.*	*p.s.i.*	*p.s.i.*	*p.s.i.*	
Sandwich high-strength paper faces; fiber-resin core	0.72	0.80	59.8	9,700	1.07	515,000	1.87	3.61	0.275
	0.58	0.89	75.0	6,600	0.83	439,000	1.52	4.51	0.289
	0.63	0.79	56.0	9,200	1.01	529,000	2.02	5.09	0.262
	0.56	0.88	72.5	7,400	0.79	409,000	1.50	4.78	0.272
	0.56	0.79	48.1	11,300	1.07	500,000	2.05	6.54	0.244
	0.44	0.90	67.8	6,800	0.84	441,000	1.74	9.00	0.254
5-ply mahogany plywood (15 percent moisture content)									
Parallel	0.58	...	...	10,000	...	....	1.69	5.02	...
Perpendicular	0.58	...	...	10,000	...	....	0.67	1.96	...
Average	0.58	...	...	10,000	...	....	1.18	3.50	...
Aluminum alloy 24ST	2.8	...	...	22,100	3.68	1,380,000	3.68	0.47	0.375
Cross-laminated high-strength paper	1.4	...	...	22,000	2.29	....	2.29	1.17	...

[a] Modulus of rigidity of sandwich materials obtained from torsion tests.

In this equation t is the total thickness, L is the length of the span and e is a constant which depends on the elastic properties of the materials, the core ratio and the manner of loading. The material characteristic which is of greatest importance in effect on e is the ratio of the modulus of elasticity of the face material to the modulus of rigidity of the core which is associated with longitudinal shear. If the modulus of rigidity of the core material is very low, effective stiffness of board will be greatly reduced, especially for relatively short spans.

The value of e is best determined by a series of bending tests on strips of several different spans. From the data shown in Table II, for a particular sandwich board, the value of e was computed to be approximately 100. Values ranging from 90 to 132 have been reported for Douglas fir plywood with grain of outer plies in the longitudinal direction.[1] These data indicate that the sandwich board that was tested had slightly better shear stiffness than the plywood.

[1] H. W. March, "Bending of a Centrally Loaded Strip of Plywood," Physics (Jan. 1936).

This discussion of the sandwich board has been limited to the case of simple bending. The gain in stiffness and strength from this type of construction and the desirable properties of a core material (i.e., low density, good shear stiffness and strength, and high ultimate strain) have been pointed out. These properties of the core are equally important for compressive loads. In the case of rectangular panels supported on all four edges and subjected to compressive loading, the torsional stiffness of the board enters as an additional factor into the determination of resistance to buckling. Torsional stiffness, however, depends for the most part on the elastic characteristics of the face material and the proportions of the board. Hence, no properties of the core other than those mentioned are important. (*Please turn to page 170*)

15—Graph for finding optimum ratio of core thickness to total thickness of board for maximum stiffness-weight ratio. **16**—*Optimum ratio of core thickness to total thickness of board for maximum flexural strength-weight ratio*

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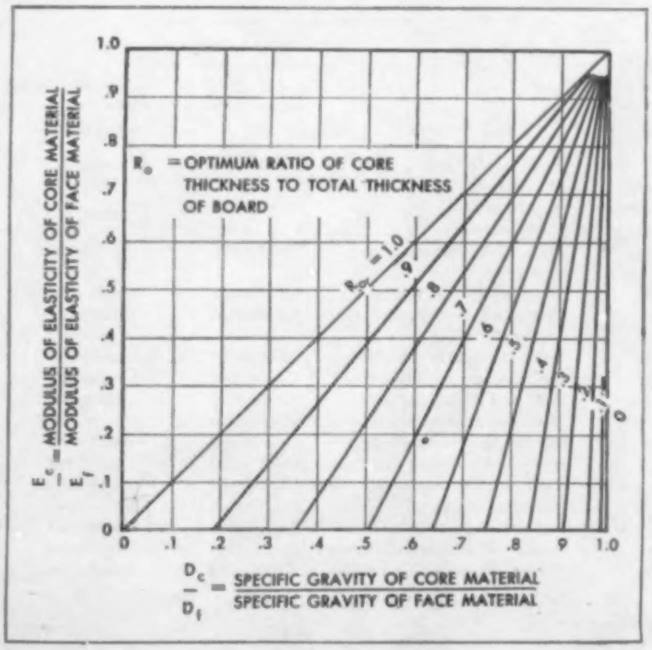

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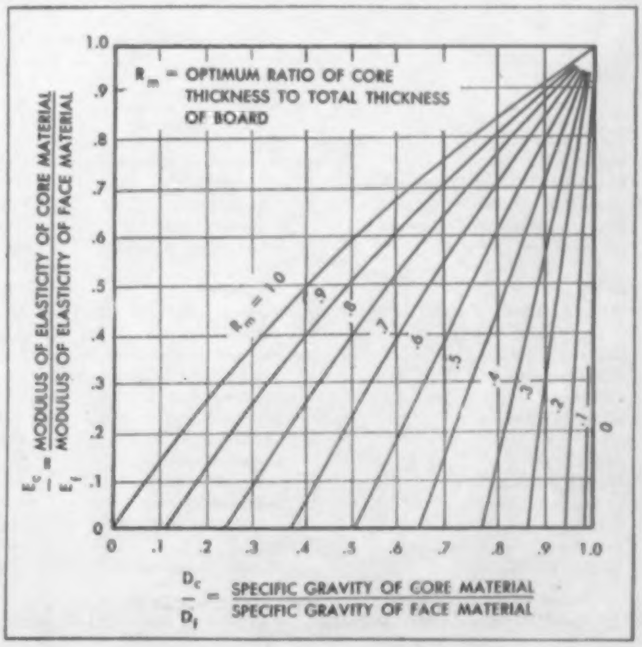


Solvent immunization by surface hydrolysis of molded cellulose esters

by W. M. GEARHART*

MOLDED articles of cellulose acetate or of cellulose acetate butyrate lack resistance to the action of many organic solvents. These plastics become tacky, swell or distort when in contact with certain solvents or plasticizers. The more active solvents such as acetone or acetic acid will, upon continued contact, finally dissolve the cellulose ester base material. The degree of deterioration is dependent upon the activity of the solvent and the type of cellulose ester. Higher acyl esters such as cellulose acetate butyrate are affected by a wider variety of solvents than cellulose acetate.

With the increase in the number of applications for molded cellulose ester plastics, it becomes evident that the usefulness of the parts could be improved if the plastic base material were made more resistant to solvent action. It has been found that by producing surface hydrolysis of the molded cellulose ester plastic, the harmful effects that result from limited exposure to certain organic solvents may be largely overcome. This reconversion of the surface composition toward cellulose affords better solvent resistance than that enjoyed by the more highly esterified cellulose esters. The resistance obtained is still dependent upon the activity of the solvent or plasticizer. The surface may be rendered insoluble to some solvent plasticizers for long exposures and to some of the more active low-boiling solvents for short exposures.

The most effective hydrolyzing conditions differ—depending on whether the base material is cellulose acetate or cellulose acetate butyrate. Cellulose acetate is more hydrophilic than cellulose acetate butyrate and will hydrolyze more readily. Cellulose acetate butyrate requires more stringent conditions to produce the same degree of hydrolysis.

* Research Laboratory, Tennessee Eastman Corp.

The method usually employed to obtain the desired surface protection is to dip the cellulose ester plastic in a solution containing 1 to 5 percent of an active hydrolyzing agent, such as sodium hydroxide, potassium hydroxide or sodium methylate, and 25 to 100 percent of a softening or penetrating agent, as methanol, ethanol, dioxane or acetone. The amount of hydrolyzing agent used is largely a matter of convenience, the only limitation being its solubility in the softening agent or in water. The softening agent should be water-soluble or should dissolve the hydrolyzing agent. It must penetrate into the cellulose ester plastic but not sufficiently to dissolve or distort it. In these respects, the alcohols function very nicely. Hydrolysis should proceed until a hydrolyzed layer of approximately 0.002 to 0.003 in. is produced. After a thorough rinsing in water until neutral to litmus, the hydrolyzed samples are dried, preferably in a 150° F. oven.

With cellulose acetate butyrate plastics, the desired degree of surface hydrolysis is obtained by dipping the samples for 3 min. in a 3 percent solution of potassium hydroxide in ethanol at room temperature, or in a 3 percent solution of sodium hydroxide in 50–50 water-ethanol mixture at 45 to 50° C. To obtain approximately the same degree of hydrolysis, cellulose acetate plastics are dipped for 1 min. in a 1 percent solution of potassium hydroxide in ethanol at room temperature, or in a 3 percent solution of sodium hydroxide in 75–25 water-ethanol at room temperature. Dips which exceed these time limits tend to produce a treated surface that will wrinkle or peel off on washing. Cellulose acetate plastics hydrolyze sufficiently in 3 min. in a 20 percent aqueous solution of sodium hydroxide whereas cellulose acetate butyrate requires 10 min. under the same conditions. The (*Please turn to page 172*)

TABLE I.—EFFECT OF 1-MIN. IMMERSION OF SURFACE-HYDROLYZED CELLULOSE ESTER PLASTICS IN CERTAIN SOLVENTS

	Cellulose acetate plastic[a]		*Cellulose acetate butyrate plastic*[b]		
Solvent	*Untreated*	*Surface hydrolyzed 1 min. in 3 percent NaOH in 75–25 water-ethanol*	*Untreated*	*Surface hydrolyzed 3 min. in 3 percent NaOH in 50–50 water-ethanol at 50° C.*	*Surface hydrolyzed 3 min. in 3 percent alcoholic KOH*
Ethanol	Sl. softening of surface	Unaffected	Surface softened	Unaffected	Unaffected
75 percent ethanol–25 percent water	Sl. softening	Sl. softening	Sl. softening	V. sl. softening	Sl. softening
50 percent ethanol–50 percent water	V. sl. softening	V. sl. softening	V. sl. softening	V. sl. softening	V. sl. softening
25 percent ethanol–75 percent water	V. sl. softening	V. sl. softening	V. sl. softening	V. sl. softening	V. sl. softening
Methanol	Sl. softening of surface	Sl. wrinkling of surface	Soft and slightly sticky surface	Unaffected	Unaffected
Butyl acetate	Unaffected	Unaffected	Soft, sticky dissolving	Unaffected	Unaffected
Methyl Cellosolve acetate	Surface soft and sticky, dissolving	Unaffected	Soft and sticky surface, dissolving	Unaffected	Unaffected
Carbitol acetate	Soft and partly dissolving	Unaffected	Soft and partly dissolving	Unaffected	Unaffected
Ethyl lactate	Soft and partly dissolving	Unaffected	Soft and partly dissolving	Unaffected	Unaffected
Cellosolve	Some soft and sl. sticky	Unaffected	Soft and sticky surface	Unaffected	Unaffected
Methyl Cellosolve	Some soft and sl. sticky	V. sl. softening	Soft and sticky surface	V. sl. softening	V. sl. softening
Carbitol	Unaffected	Unaffected	Sl. soft and v. sl. sticky	Unaffected	Unaffected
Acetone	Surface dissolving	Unaffected	Surface dissolving	Unaffected	Unaffected
Methyl ethyl ketone	Soft and sl. sticky	Surface pimpled	Soft, sticky dissolving	Unaffected	Unaffected
Ethylene dichloride	Soft and sticky	Surface pimpled	Soft and sticky	Unaffected	Unaffected
Nitroethane	V. soft and sticky	Surface pimpled	V. soft and sticky	Unaffected	Unaffected
Triacetin	Sl. soft	Unaffected	Some softness and stickiness	Unaffected	Unaffected
Methyl phthalate	Sl. soft and sticky	Unaffected	Some softness and stickiness	Unaffected	Unaffected

[a] Based on cellulose acetate of 38 percent acetyl content.
[b] Based on cellulose acetate butyrate of 12 percent acetyl and 38 percent butyryl content.

TABLE II.—EFFECT OF CONTINUOUS IMMERSION OF SURFACE-HYDROLYZED AND UNHYDROLYZED CELLULOSE ESTER PLASTICS IN CERTAIN SOLVENTS

Solvent	Cellulose acetate plastic[a] Untreated	Cellulose acetate plastic[a] Surface hydrolyzed 1 min. in 3 percent alcoholic KOH	Cellulose acetate plastic[a] Surface hydrolyzed 1 min. in 3 percent NaOH in 75–25 water-ethanol	Cellulose acetate butyrate plastic[b] Untreated	Cellulose acetate butyrate plastic[b] Surface hydrolyzed 3 min. in alcoholic KOH	Cellulose acetate butyrate plastic[b] Surface hydrolyzed 3 min. in 3 percent alcoholic KOH	Cellulose acetate butyrate plastic[b] Surface hydrolyzed 3 min. in 3 percent NaOH in 50–50 water-ethanol at 50° C.
	Immersed 36 hr.	*Immersed 16 hr.*	*Immersed 36 hr.*	*Immersed 36 hr.*	*Immersed 16 hr.*	*Immersed 36 hr.*	*Immersed 36 hr.*
Ethanol	Swelled	Swelled	Swelled; blushed	Swelled badly	Swelled	Swelled badly	Swelled along edge
75 percent ethanol-25 percent water	Swelled badly	...	Some swelling	Sl. swelling	...	Some swelling; some blushing	Some swelling
50 percent ethanol-50 percent water	Some swelling	...	Some swelling	Sl. swelling along edges	...	Sl. more swelling than blank	Sl. more swelling than blank
25 percent ethanol-75 percent water	Sl. swelling	...	Sl. swelling	Unaffected	...	Unaffected	Practically unaffected
50 percent isopropanol-50 percent water	Swelled badly[c]	...	Swelled badly	Swelled badly	...	Some swelling; some blushing	Some swelling
Methanol	Swelled badly	...	Swelled badly	Swelled badly	...	Swelled badly; partly dissolved	Swelled badly; blushed
Butyl acetate	Non-solvent	...	...	Dissolved	Swelling along edges	Some swelling along edges	Some swelling along edges
Methyl Cellosolve acetate	Dissolved	Dissolved	Swelled badly; skin wrinkled	Dissolved	Edges swelled slightly	Swelled badly	Sl. swelling along one edge
Carbitol acetate	Dissolved	Partly dissolved	Swelled some	Dissolved	Sl. swelling along edge	Some swelling	Sl. swelling
Ethyl lactate	Dissolved	Dissolved	Swelled badly; skin wrinkled	Dissolved	Swelled edges; skin wrinkled	Swelled some; skin wrinkled	Swelled edges slightly
Triacetin	Surface swelled and dissolving	Unaffected	Unaffected	Partly dissolved	Unaffected	Unaffected	Unaffected
Methyl phthalate	Surface swelled and dissolving	Unaffected[c]	Unaffected[c]	Partly dissolved	Unaffected[c]	Unaffected[c]	Unaffected[c]
Methyl Cellosolve	Dissolved	...	Surface partly dissolved	Dissolved	...	Surface partly dissolved	...
Cellosolve	Dissolved	Partly dissolved; swelled badly	Swelled badly	Dissolved	Swelled badly	Swelled badly	Sl. swelling
Carbitol	Swelled	Swelled	Swelled badly	Swelled some	Swelled badly; skin peeling off	Some swelling; skin peeled off	Sl. swelling
Ethylene dichloride	Swelled badly	Swelled badly; distorted	Swelled badly	Dissolved	Sl. swelled	Swelled badly; skin wrinkled	Some swelling, esp. along edges
Methyl ethyl ketone	Dissolved	Dissolved	V. badly swelled	Dissolved	Swelling along edges	Swelled badly	Some swelling along edges
Oil of lavender	Unaffected	...	Unaffected	Swelled badly	...	Unaffected	Unaffected
Oil of pennyroyal	Surface softened	...	Unaffected	Dissolved	...	Sl. swelling of edges	Unaffected
Oil of lemon	Unaffected	...	Unaffected	Unaffected	...	Unaffected	Unaffected
Oil of eucalyptus	Unaffected	...	Unaffected	Unaffected	...	Unaffected	Unaffected
Oil of wintergreen	Sl. swelling	...	Unaffected	Dissolved	...	Unaffected	Unaffected

[a] Based on cellulose acetate of 38 percent acetyl content.
[b] Based on cellulose acetate butyrate of 12 percent acetyl and 38 percent butyryl content.
[c] Immersed for 310 hr. without affecting sample.

Effect of prolonged heating on some physical properties of compreg

by DAVID BAKER* and JOSEPH E. GURVITCH†

PRIOR to the war, little or no compreg was made in this country. This year approximately 1,000,000 lb. will be manufactured in the United States for aircraft propellers alone. The development of compreg has been so rapid that the accumulated information concerning its properties is by no means complete. Since little is known about the effect of heat on compreg, this investigation was undertaken to determine the permanent effect of prolonged heating on some of the physical properties of this product (wood which has been impregnated, laminated and compressed), with special reference to its use in aircraft propellers.

Compreg[1] made up of 0.1-in.-thick rotary-cut maple veneers impregnated with phenol-formaldehyde resin solution by a vacuum-pressure method was used in obtaining test data. The grain of each ply was laid parallel to that of the others, and compression amounted to approximately 40 percent of the normal wood thickness. The compreg specimens were subjected to continuous exposure at 160° F. and were tested after various intervals of heating. The temperature of 160° F. was chosen since it is generally considered the maximum to which most aircraft are subjected. Tests were made on compreg specimens subjected to the above condition for 8, 24, 48, 96, 168, 336 and 480 hours. Upon removal from the oven the test specimens were placed in a desiccator and allowed to cool to room temperature for at least 24 hr. prior to the test.

Testing procedures

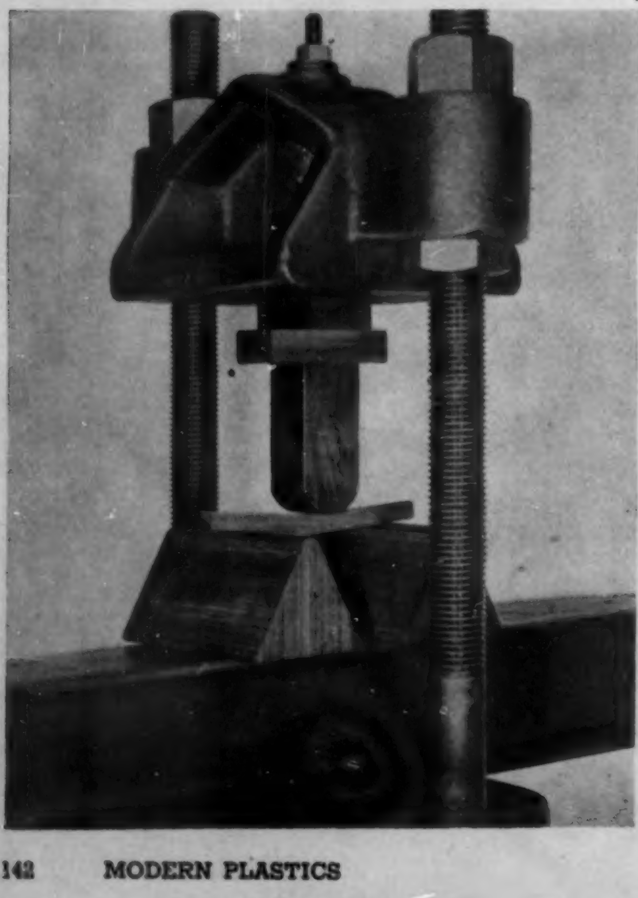
During the test the following properties of the product were studied—modulus of rupture, shear parallel to the grain and laminations, shear parallel to the grain and perpendicular to the laminations, Izod impact, moisture absorption, dimensional stability and specific gravity. The dimensions of the test specimens are given in Table I, while Figs. 1, 2 and 7 show various test set-ups. The appearance of the specimens before and after testing is shown in Fig. 6.

The modulus of rupture specimens and both types of shear specimens were broken in a 20-ton hydraulic press. The beam span for the modulus of rupture test was 5 in. with a 1-in. overhang beyond the V block (Fig. 1). Pressure was applied at the beam center. Strength properties in shear parallel to the grain and perpendicular to the laminations were determined with a double-shear jig which can be seen in Fig. 2. The shear plunger is $^{1}/_{4}$ by $^{5}/_{8}$ inch. The test specimen for shear parallel to the grain and lamination was of the single-shear type, and the procedure (*Continued on page 176*)

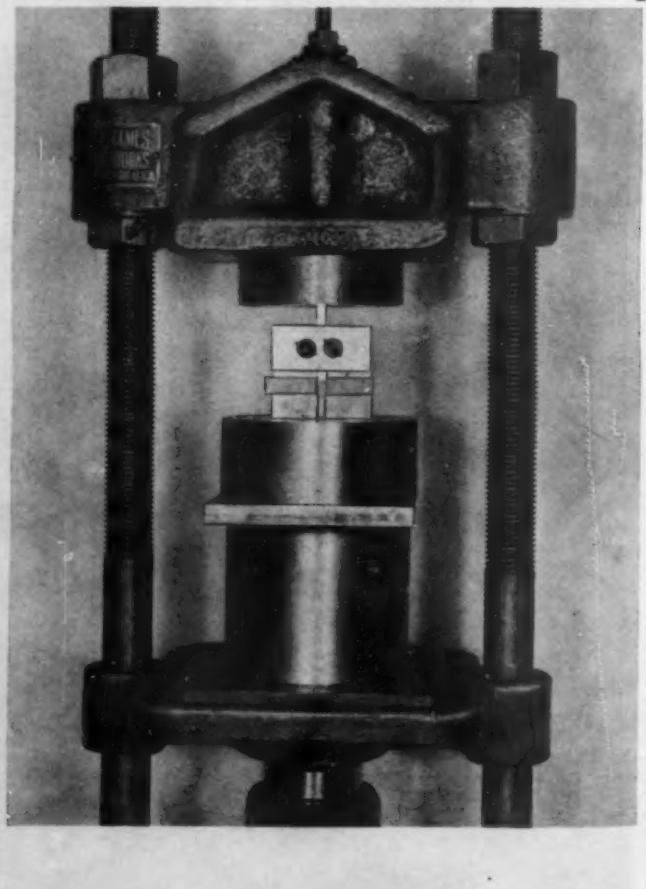
* Aircraft Div., Goodyear Aircraft Corp.
† Propeller Div., Engineering and Research Corp.
[1] Panelyte 620, Panelyte Div., St. Regis Paper Co.

1—Equipment used in the modulus of rupture (static bend) test. 2—Double shear set-up for testing shear parallel to the grain and perpendicular to the laminations. This illustration shows the test machine and the shear jig

1



2



TECHNICAL BRIEFS

Abstracts of articles on plastics in the world's scientific and engineering literature relating to properties and testing methods, or indicating significant trends and developments.

Engineering

VINSOL-RESIN-TREATED CEMENTS AND THEIR USE IN HIGHWAY CONSTRUCTION. J. F. Barbee. Concrete (Mill ed.) *52*, 103-4, 108 (Jan. 1944). Concrete having excellent durability, as measured by its resistance to freezing and thawing and to the application of salt or calcium chloride, can be produced with Portland cement ground with vinsol resin or by adding a vinsol resin-sodium hydroxide solution to the materials at the mixer. This increased durability seems to be a function of the air entrained in the concrete during mixing. The best results in pavement mixes from a standpoint of both durability and strength are found with a loss in weight of between 3 and 5 lb./ft. For higher losses in weight there is no appreciable increase in durability, but there is some loss in strength.

THE WELDING OF THERMOPLASTIC MATERIALS BY MEANS OF RADIO FREQUENCY CURRENTS. H. P. Zade. Plastics *8*, 100–9 (Mar. 1944). The information on the use of high-frequency currents to weld thermoplastics is reviewed. High frequency currents are being used to spot, butt and lap weld as well as for continuous seam welding. The shape of the electric field and of the electrodes and the high field strength are important factors in obtaining satisfactory welds. A method for exploring the actual high-frequency field for a given set of conditions is described. Several examples of welding pieces of methyl methacrylate resin together are illustrated and discussed. One of the common pitfalls is overheating which causes the formation of bubbles; accurate control of time and current is necessary to eliminate this fault. Forty-six literature and seventy patent references are given.

INFLAMMABILITY AND EXPLOSIBILITY OF POWDERS USED IN THE PLASTICS INDUSTRY. I. Hartmann and J. Nagy. Bur. Mines Bull. R. I. 3751, 38 (May 1944). Fifty-seven powder samples comprising 31 resins, 15 molding compounds, 4 synthetic resin ingredients and 7 fillers for molding compounds were tested to determine the minimum ignition temperature, minimum energy needed for ignition of dust clouds, relative inflammability, minimum concentration in a dust cloud to permit ignition and flame propagation, maximum pressure and rate of pressure rise developed in small explosions, reduction in oxygen content of the air necessary to prevent ignition and the rate of moisture absorption in humid atmospheres. The ignition temperatures for all except asbestos, asbestine and mica which did not ignite, ranged from 320 to 900° C. All except asbestos, asbestine, mica, chlorinated paraffin and certain vinyl resins could be ignited by electric spark. The minimum explosive concentration ranged from 0.015 to 0.175 oz./ft^3. Most powders are more sensitive to ignition by hot surfaces than by electric sparks. The maximum pressure developed in explosions and the rate of pressure rise were sufficient to show that plastic dust explosions may cause widespread destruction of plant property and possible loss of life.

METAL PLATING OF PLASTICS. Can. Metals and Metallurgical Ind. *7*, 33–4 (Feb. 1944). A process for plating plastics with metal is described. The piece to be plated is roughened mechanically and coated with metal chemically to provide a conductive surface. Any metal can then be electroplated on the plastic. The dimensional stability, heat resistance, water absorption and oil absorption are improved by this process. The strength of the bond between macerated-fabric filled phenolic plastic and a layer of copper 0.0005 in. thick was 500 p.s.i. The strength of the bond between other types of plastics and copper varies from 300 to 800 p.s.i.

DIELECTRIC HEATING SPEEDS CURING OF PLASTIC LAMINATES. R. W. Auxier. Product Eng. *15*, 299–301 (May 1944). This is an analysis of the advantages of high-frequency heating compared with conventional methods of curing laminates. A formula is given for determining the heat developed in the sample when voltage, frequency and electrical characteristics of the material are known.

Chemistry

SETTING TEMPERATURE OF HIGH-MOLECULAR GLASSES AND THEIR CHEMICAL STRUCTURE. E. Jenckel. Kolloid-Z. *100*, 163–70 (1942). The setting temperatures of a number of high polymers are reported. The setting temperature is defined as the temperature region above which the coefficient of thermal expansion is large and below which it is small. The setting temperature is related to the viscosity; increased difficulty in the relative movement of the molecules corresponds to higher setting temperatures. This is shown by the high setting temperatures of polymers in which molecular movement is hindered by the presence of rings in the side-chains, such as polystyrene, by cross-linking through principal valencies, such as polydivinylbenzene, and by dipole formation, such as polyacrylic acids. This is also shown by the lower setting temperatures of polymers in which molecular movement is enhanced by the presence of mobile aliphatic units in the side chains, such as polybutadiene, and by screening of the dipole-forming forces, such as polyacrylic esters.

MOLECULAR WEIGHT OF NATIVE CELLULOSE. N. Grálen and T. Svedberg. Nature *152, 625* (1943). Measurements of the sedimentation and diffusion velocities of cellulose in cuprammonium solutions in an atmosphere of nitrogen are reported. For reliable results the measurements were extrapolated to zero concentration; the molecular weights were calculated by the Svedberg formula. The following molecular weights and degrees of polymerization are reported: unbleached cotton linters, 1,500,000 and 9200; raw Georgia cotton, 1,000,000 and 6200; nettle fiber cellulose, 1,760,000 and 10,800; ramie, 1,840,000 and 11,300; sulfite wood pulp, 460,000 and 2900. The results do not agree with Staudinger's hypothesis that a linear relation exists between the relative viscosity and the molecular weight. The sedimentation data indicate that the longer the molecules the greater the tendency to curl.

X-RAY STUDIES OF CHAIN POLYMERS. I. Fankuchen and H. Mark. J. Applied Phys. *15*, 364–70 (Apr. 1944). The results of an x-ray study of the structure of chain polymers, particularly nylon, are described.

PROTEIN-ALDEHYDE PLASTICS, D. C. Carpenter and F. E. Lovelace. Ind. Eng. Chem. *36*, 680-2 (July 1944). The combining ratios between formaldehyde and deaminized casein are established over a concentration range up to 6.85 percent formaldehyde. The general law, relating bound formaldehyde to total formaldehyde over the concentration range investigated, is shown to be the absorption law, $X = KC^n$ where X is the grams of formaldehyde bound per gram of protein, C is the concentration of aldehyde, and K and n are constants. The value of n, 0.595, is the same for

deaminized casein as for acid casein previously investigated. The values for K are very different; the values for log K for acid casein, partly deaminated casein and completely diaminated casein are —2.145, —2.352 and —2.490, respectively. The aldehyde bound at any empirically chosen aldehyde concentration is 63 and 45 percent respectively, for partly deaminized and completely deaminized casein, as compared with the original acid casein. The aldehyde bound by acid casein and deaminized casein agrees closely with that expected from the content of certain individual amino acids in the respective proteins.

Properties

DIELECTRIC MEASUREMENTS ON POLYVINYL CHLORIDE PLASTICIZED WITH "INNER" AND "OUTER" PLASTICIZERS. F. Würstlin. Z. Elektrochem. *48*, 311–14 (1942). The dielectric losses and dielectric constants of various vinyl chloride polymers were measured at 50 cycles per second between 20 and 100° C. The polymers investigated were pure polyvinyl chloride, copolymers of vinyl chloride and butyl acrylate, copolymers of vinyl chloride and methyl acrylate, polyvinyl chloride plasticized with tricresyl phosphate and mixtures of the various copolymers. Mobility of the chlorine atoms caused anomalous dispersion and absorption. The maximum dielectric loss for polyvinyl chloride occurred at 91° C. In the copolymers the other component acted as an "inner" plasticizer and increased the mobility of the chlorine atoms; this decreased the temperature of the maximum dielectric loss. The tricresyl phosphate had the same effect. When copolymers were mixed, the maximum sections of the dielectric loss-temperature curves flattened out or disappeared entirely. The same differences between "outer" and "inner" plasticizers was found for the dielectric constant. Mixtures of copolymers showed a spreading of the region of anomalous dielectric constant-dispersion, and the increase in dielectric constant with temperature was broader with mixtures of copolymers than with pure copolymers. The region of congealment and the location of the anomalous dispersion are related to the molecular weight.

PHYSICAL PROPERTIES OF A STRUCTURAL PLASTIC MATERIAL. C. W. Armstrong. Trans. A. S. M. E. *66*, 135–8 (Feb. 1944). Data concerning the tensile, compressive, bending and bearing properties of polyester-bonded glass-fabric laminates are reported. The tensile strengths vary from 19,000 to 54,000 p.s.i., the tensile modulus from 830,000 to 3,000,000 p.s.i., buckling stability from 280,000 to 790,000 p.s.i., the modulus of rupture from 11,000 to 15,000 p.s.i. and the bearing strength from 16,600 to 21,300 p.s.i. These laminates possess physical properties which enable this material to be used to good advantage in many airplane structural applications. The ability to mold large contoured assemblies with substantially no pressure will result in substantial savings in cost and in man-hours of time required for the tooling and fabrication of many assemblies now made of metal. Known disadvantages include the anisotropic properties of fabric laminates, the length of time required to complete the curing of each part, the low values of the modulus of elasticity, the low bearing strength and the present incompleteness of important physical data.

HYSTERESIS LOSSES IN HIGH POLYMERS. H. S. Sack, J. Motz and R. N. Work. J. Applied Physics. *15*, 396–7 (Apr. 1944). A brief explanation of hysteresis losses in high polymers.

EFFECT OF ALTITUDE ON ELECTRICAL INSULATION. L. J. Berberich, A. M. Stiles, G. L. Moses and C. G. Veinott. Aero Digest *45*, 84–6, 207–10, (Apr. 1, 1944) and 122, 124, 126, 224-5 (May 15, 1944). The breakdown strength of air and the surface flashover behavior of a number of laminated phenolic plastics have been investigated under conditions corresponding to an altitude range from sea-level to 65,000 feet. The various atmospheric conditions encountered by aircraft in this altitude range were simulated by use of a special test chamber. Moisture in the frozen form, such as ice and snow, does not lower either the breakdown voltage of air or the flashover voltage of an insulating surface. Moisture in the vapor form does not have a significant effect on the breakdown strength of small air gaps (1/32 to ½ in.) or the flashover of insulating surfaces, provided condensation is absent. Moisture in the cloud or suspended droplet form lowers the breakdown strength of small air gaps. Moisture condensation on the surface of an insulating material results in a marked lowering of the flashover voltage. Some differences were observed in the flashover behavior of various materials, particularly at low temperatures and with d-c voltages. Dielectric constant changes with temperature are believed to play a role. These differences in materials are small compared with the safety factors that must be allowed in practical designs. The over-potential test voltages necessary at sea level to determine the adequacy of striking and creepage distances for high-altitude operation may result in excessive stresses on the solid insulation. This can be avoided by conducting such tests in a partial vacuum. On the basis of the data obtained and general experience with various types of electrical apparatus, specific striking and creepage or flashover distances have been proposed which are believed to be adequate for the electrical equipment used in aircraft.

ELECTRICAL PROPERTIES OF PLASTICS VARY OVER WIDE RANGE. W. S. Larson, Product Eng. *15*, 329–32 (May 1944). The electrical properties of various commercial plastics are reviewed. Data are given on dielectric strength, dielectric constant, power factor, arc resistance and insulation resistance.

BEHAVIOR OF SYNTHETIC PHENOLIC-RESIN ADHESIVES IN PLYWOOD UNDER ALTERNATING STRESSES. A. G. H. Dietz and H. Grinsfelder. Trans. A. S. M. E. *66*, 319–28 (May 1944). Fatigue tests indicate that in birch plywood and laminated wood bonded with thermosetting phenol-formaldehyde resins, and in plywood bonded with an aqueous solution of cold-setting urea-formaldehyde resin, at room temperatures: 1) Fatigue failures are primarily wood failures. 2) Delamination of the veneers occurs very seldom before the outer plies have given way. 3) Laminated material may be expected to withstand at least 2,000,000 and film-bonded plywood at least 10,000,000 stress reversals without failing when stressed to 25 percent or less of the static modulus of rupture.

ELECTRICAL ANISOTROPHY OF XEROGELS OF HYDROPHILE COLLOIDS. S. E. Sheppard and P. T. Newsome. J. Chem. Phys. *12*, 244–8 (June 1944). A number of colloid materials — proteins, plastics, etc., — were coated in sheet form and "fibered" internally by stretching to 100 percent or more elongation. Circular disks were cut from the fibered sheets and their degree of orientation was measured in an alternating electric field. The relation of the orientation measured to field strength, thickness, humidity and moisture content is discussed. Induced electrical anisotrophy is not shown by all kinds of natural and synthetic colloids; it is shown by hydrophile and not by organophile xerogels. With most of these materials the electrical response depends upon the relative humidity and the absorbed water content, but with polyvinyl alcohol the effect was independent of the absorbed water.

COMPARATIVE TESTS ON BEARINGS MADE OF PLASTICS. E. Heidebroek and H. Zickel. Kunststoffe *33*, 243–9 (1943); Chem. Ab. *38*, 3041–2 (June 20, 1944). Sliding contact bearings made of fabric-filled phenol-formaldehyde, cresol-formaldehyde and polyvinyl

chloride plastics were tested on a special bearing test machine. The maximum allowable pressure for the phenol and cresol products is 40 kg/cm²; that for the polyvinyl chloride is 25 kg/cm².

Testing

FACT AND FANCY IN MODERN PLASTICS DESIGN. Plastics (London) *8*, 170–6 (Apr. 1944). This is a review of an article by Tschudi in "Schweizer Archiv" *9*, 360 (1943). The relation between properties of one urea and four phenolic plastics as determined with standard test methods and the properties in practical moldings is discussed. Values for various properties are given.

THE EFFECT OF THIXOTROPY ON PLASTICITY MEASUREMENTS. H. Green and R. N. Weltmann. J. Applied Phys. *15*, 414–22 (May 1944). The effect of thixotropic breakdown on rheological measurement is to shift the position of the flow curve. This shift is not a certain percentage of the total distance between the consistency of the untouched material and that of the material after complete breakdown because: 1) plastic viscosity cannot be determined without forcing the material to flow and 2) there is no way of knowing when a completely broken down state is attained. No breakdown takes place in forming the down curve of the loop when the loop is produced with a rotational viscometer. The position of the down curve depends on the top velocity gradient and the length of time of its application. This presents a relatively easy method for obtaining results which can be duplicated. In a suitably constructed rotational viscometer, the gradient can be adjusted to the desired value by selecting the correct r.p.m. and the time of application can be measured with a stopwatch. Thus the energy used to produce breakdown can be controlled and duplicated. Tests made by six different workers with different viscometers show that this method gives reproducible results.

THE ANALYSIS OF RESIN FINISHES. F. P. Brennan. Rayon Textile Monthly *25*, 339–41 (July 1944). A list of some of the finishing materials likely to be found on fabrics is given. Test methods are described. The carbazole test is used for urea-formaldehyde, the resorcinol test for phthalate alkyds, a dyeing test for polyethylene, the diphenylamine test for cellulose nitrate, a dyeing test for methyl and ethyl cellulose, an acetone solubility and dyeing test for cellulose acetate. These procedures are also described in A. S. T. M. Method of Test D683-42T entitled "Tentative Methods of Test for Identification of Finishes on Textiles."

TENTATIVE STANDARD TEST METHODS FOR POLYVINYL CHLORIDES. P. Nowak. Kunststoffe *33*, 297–301 (1943); Chem. Ab. *38*, 3041 (June 20, 1944). Tentative test methods of the Verein Deutscher Chemiker for polyvinyl chloride are described. These include various chemical and physical tests for both the plasticized and unplasticized resin. Procedures are given for determining the pH of the aqueous extract, chloride content, thermal stability, ash, volatiles, sieve analysis, bulk factor, viscosity, rigidity of solutions, milling and curing characteristics, tensile strength and ultimate elongation, heat distortion, brittle point, plasticizer content, filler content and specific resistivity.

Synthetic rubber

STRESS-STRAIN DATA FOR VULCANIZED RUBBER UNDER VARIOUS TYPES OF DEFORMATION. L. R. G. Treloar. Trans. Faraday Soc. *40*, 59–70 (Feb. 1944). This investigation was made to determine the usefulness of Wall's equation for calculating the stress-strain properties of rubber. Stress-strain data are given for two types of vulcanized rubber: 1) an 8 percent S rubber, and 2) a latex rubber. The types of deformation studied were simple elongation, 2-dimensional extension (or compression), pure shear, and combined elongation and shear. Comparison with the theoretical relations based on the molecular-network model shows the agreement to be good for the 2-dimensional extension, but not as good for simple elongation and shear. The effect of combined elongation and shear is satisfactorily accounted for. The theory provides a satisfactory explanation of rubberlike elasticity, and forms a useful basis for the description of the mechanical properties of rubber subjected to large deformations of any type.

STRESS RELAXATION OF NATURAL AND SYNTHETIC RUBBER STOCKS. A. V. Tobolsky, I. B. Prettyman and J. H. Dillon, J. Applied Phys. *15*, 380–95 (Apr. 1944). Measurements of stress decay as a function of time made at constant elongation on thin bands of gum and tread type natural rubber (Hevea), neoprene, Butyl, Buna S and Butaprene N stocks indicate that both secondary and primary bond relaxation occur. Practically complete relaxation is observed to take place in the experimental time, about 100 hr., at temperatures at and above 100° C. The manner in which the rate of relaxation depends on temperature and the fact that the rate is independent of elongation and of the presence of carbon black in the vulcanizate, indicate that stress decay is caused by a definite chemical reaction which deteriorates the rubber structure, and oxidative scission is suggested as the mechanism of deterioration of the primary bonds. The stress relaxation data, obtained over a temperature range from − 50 to + 150° C., appear to verify modern concepts of the structure of elastomers. Theoretical equations are derived which give very good agreement with the observed relaxation data at high temperatures. The free energy of activation for the oxidative scission is found to be 30.37 kcal/mole for the Hevea gum stock, and differs from this value by less than ± 2.0 kcal/mole for all other stocks, indicating the same general reaction for all. However, these small differences in free energy of activation correspond to considerable differences in times of decay, which might be significant in evaluating the resistance of rubber stocks to deterioration. Eight references are given.

PROCESSING BEHAVIOR OF HIGH POLYMERS. R. L. Zapp and A. M. Gessler. Ind. Eng. Chem. *36*, 656–61 (July 1944). The effect of high polymer deformation depends upon the relative amount of high elastic and viscous deformation. To predict processing behavior by plasticity measurement, the relative extent of high elastic and viscous deformation should govern the conditions of test. Since most processing equipment deforms polymers at a rate at which high elastic deformation is prominent, conditions should be established at fairly high rates of deformation to a constant deformation value. If plasticity and elasticity of polymers are determined under these conditions over a temperature range, thermoelastic and thermoplastic differences may be noted which correlate with processing behavior.

RECENT PROGRESS IN SYNTHETIC RUBBERS. P. M. Torrance. SAE J. *52*, 133–6 (Apr. 1944). Recent accomplishments in the application of synthetic rubbers in tires and automotive mechanical goods are reviewed. Synthetic rubber tires are satisfactory when used at reasonable speeds and normal loads on passenger cars and light trucks. When rayon or nylon cord is used in place of cotton, greatly improved performance results because of the reduction in running temperatures. GR-S inner tubes are satisfactory except for the smaller sizes used on drop-center rims where the high wall stretch causes premature failures. The properties of synthetics appear to be very satisfactory for solid tire applications such as bogie rollers and rubber tank tracks. Synthetic rubbers are very satisfactory for such uses as radiator hose, brake hose, heater hose, fan belts, motor mounts, seals, gronmmets, gaskets, insulators, dust covers, channel rubbers, door edging and windshield wipers.

PLASTICS DIGEST

This digest includes each month the more important articles of interest to those who make or use plastics. Mail request for periodicals directly to publishers.

General

PLASTICS — THEIR APPLICATION TO ROAD VEHICLES. F. Walls and J. E. Sisson. Automobile Eng. *34,* 157–62 (Apr. 1944). The use of plastics in automobiles previous to the war is reviewed. New techniques of forming plastics are described and their possible application to production of motorcar parts are pointed out. Thermoplastic resin sheets may find application in side windows, instrument panels, panel lighting devices and roof lights. Laminates may find use for special body work such as commercial bodies, models and fenders. Plywood may find use in car bodies. Extruded plastics may be used for window fillets, decorative beadings, tubing for covering hand rails and covering brake and gear levers. Other applications are upholstery materials and floor coverings.

THE CHEMISTS' WONDERLAND. PLASTICS THROUGH THE LOOKING GLASS. G. M. Kline. Chem. Eng. News *22,* 890–9 (June 10, 1944). The types, specifications and present and future applications of plastics are discussed. The analogies drawn between the plastics industry and Lewis Carroll's fantasy "Alice's Adventures in Wonderland and Through the Looking Glass" give a new and refreshing approach to a general discussion of plastics.

PLASTICS IN POSTWAR BUILDING. Plastics (London) *8,* 267–9 (June 1944). This is an abstract of a report of a committee on application of plastics to building problems. Plastics are considered for use in building as load-bearing members; linings or coverings for walls, ceilings and floors; structural components; fittings; tubes and pipes; and finishes such as paints, varnishes and lacquers. Design, standardization, raw materials and recommendations regarding future developments are discussed. Research is recommended on 1) use of resin-bonded laminated wood as a structural material, 2) production of composite boards, 3) improvement in durability, 4) molding edges on sheets, 5) plastic tubing for domestic piping, and 6) manufacture of large components such as staircases and window frames.

STRUCTURAL FEATURES OF GERMAN AIRCRAFT. D. M. A. Leggett and J. H. H. Davison. J. Roy. Aeronautical Soc. *48,* 167–201 (June 1944). The use of plastics on German military aircraft is very limited. Plastic items include control pulleys, drive couplings for engine accessories, electrical and radio parts, and a few aerial masts. The use of wood is almost entirely confined to propeller blades. The rigid fuel tanks are built of layers of fiber, leather and rubber. The flexible fuel tanks consist of layers of rubber and cotton fabric. The control surfaces are mostly covered with fabric and airplane dope.

Materials

SARAN — MOLDED AND EXTRUDED PRODUCTS, AND THEIR APPLICATION. W. C. Goggin. Can. Chem. *28,* 225–7, 231 (Apr. 1944). This article deals with the production, properties, forming and uses of the copolymer of polyvinylidene chloride and vinyl chloride.

PREPARATION AND PROPERTIES OF THE *n*-ALKYL ACRYLATES. C. E. Rehberg and C. H. Fisher. J. Am. Chem. Soc. *66,* 1203–7 (July 1944). Higher *n*-alkyl acrylates having 2 to 16 carbon atoms in the alkyl group were prepared in high yields by the alcoholysis of methyl acrylate. The monomeric esters were emulsion polymerized, and the coagulated polymers were examined briefly to determine the influence of chain length of the alkyl group upon the properties of the polymer. As the chain length of the alkyl group increased, the polymers became softer and tackier at room temperature (up to and including tetradecyl acrylate). The polymer of *n*-hexadecyl acrylate was a waxlike solid at room temperature but soft and tacky above 35° C. As the molecular weights increased, the brittle points of the first eight polyalkyl acrylates became lower; beyond octyl acrylate, which had a brittle point of –65° C., the brittle points became higher.

PAPER-BASE PLASTICS. PART I. THE PREPARATION OF PHENOLIC-LAMINATED BOARDS. H. L. Cox and K. W. Pepper. J. Soc. Chem. Ind. *63,* 150–4 (May 1944). The preparation of reinforced plastics from paper and phenol-formaldehyde resin is described. The influence of various factors in the preparation of such material on mechanical properties is discussed. The resin solution should impregnate the paper thoroughly and uniformly. Close control of the drying process is essential and the impregnated paper should be dried as much as possible consistent with complete bonding during pressing. The optimum resin content is that which just fills the air voids in the paper at any given pressure. This optimum resin content is indicated by a maximum in the density-resin content curve. An increase in shear strength is obtained by an improvement in the degree of impregnation, by use of either absorbent paper or a more penetrating aqueous solution with non-absorbent papers. The strength of the resin itself is important, since under the most favorable conditions, boards made from alcoholic solution have higher shear strength than those from aqueous solution. The high values of shear strength require very uniform distribution of the resin through the board. If there is a deficiency of resin even in the middle of a sheet of paper, failure may start by separation of the paper itself. Even with the best impregnation, the shear strength of the board is no better than that of the unfilled resin. In order to improve on the value of 7000 to 9000 p.s.i., two possibilities exist. A resin with higher shear strength could be used or the resin might be reinforced by fibers cross-bonding the laminations. In the latter case, there would be a loss in tensile strength, but this would be well compensated if there were a substantial increase in shear strength.

POLYVINYL ALCOHOL. I. Jones. British Plastics *15,* 380–4, 408; *16,* 77–83, 122–9 (Dec. 1943, Feb., Mar. 1944). The manufacture, chemical reactions and properties of polyvinyl alcohol are described in detail. Plasticizers, properties of polyvinyl alcohol plastics, and applications of the plastic compositions are also discussed.

Molding and fabricating

MOLDED THREADS. J. E. Ball. British Plastics *16,* 207 (May 1944). A method for overcoming the errors, which result from shrinkage on curing or molding, in molded threads is described. This consists of making proper allowance for these changes. A method of calculating these allowances is given.

PLANNED MOLD MAINTENANCE SERVICE. W. M. Halliday. Plastics (London) *8,* 237–45, 279–92 (May, June 1944). The factors necessary for adequate mold maintenance are discussed. These include not only actual repairs but items such as inspection, checking, adjusting, replacements, test-

ing, breaking-in, training operator, daily care, storage, records needed and suggested methods for keeping records for individual molds.

KNOWLEDGE OF SHRINKAGE AIDS IN DESIGN OF PLASTIC PARTS. C. R. Simmons. Product Eng. *15*, 414–15 (June 1944). Allowances for shrinkage must be made in designing dies for molding plastic parts if satisfactory molds are to be made. In transfer molding, the shrinkage may be 25 percent lower than in compression molding. Consequently, closer tolerances may be maintained in transfer molding. Shrinkage depends on the state of cure, shape and size of the piece, plasticity of the material and mold design. It is caused by thermal contraction, polymerization of the resin and modulus of elasticity. Shrinkage can be determined by molding standard test bars, from the coefficient of linear thermal expansion and the modulus of elasticity. Uneven shrinkage, which creates stresses, is caused by uneven cooling, improper placement and spacing of ejector pins, improper handling and inserts. Design features based on the above points to control shrinkage are discussed.

Applications

SUBSTITUTES FOR SILK INSULATION OF FINE WIRES. A. Brookes. Engineering *157*, 263–4, 281–3 (Apr. 7 and 14, 1944). The properties of regenerated cellulose and cellulose acetate rayons, nylon and polyvinyl acetal are examined to determine the suitability of these materials as substitutes for silk for insulation on fine wires. Cellulose acetate rayon and nylon are the best of the materials investigated.

FURFURAL RESIN ADHESIVES FOR AIRCRAFT USE. J. Delmonte. Pacific Plastics *2*, 14–15 (Apr. 1944). Two new furfural resin adhesives are described. The high-temperature setting type is intended for use with metal products. The low-temperature setting type is used with rubber, wood and plastics. These furane resins are thermosetting. Mechanical tests show that bond strengths are stronger than rubber, wood and laminated phenolic plastics since failure occurs in the bonded materials.

CONDUCT OF AMINO ACIDS IN SYNTHETIC ION EXCHANGERS. D. T. Englis and H. A. Fiess. Ind. Eng. Chem. *36*, 604–9 (July 1944). The reactions of representative amino acids with various forms of synthetic ion-exchange materials were studied. All the amino acids that were tested reacted with the hydrogen form of the cation exchangers. Using the column method, the capacities of two commercial exchangers — Amberlite IR-1 and Zeo-Karb H — for glycine, leucine, norleucine, phenylalanine, tryptophan, hydroxyproline, glutamic acid, asparagine and lysine hydrochloride were determined. A fairly uniform capacity of each individual exchanger, in terms of equivalents of the acids examined, suggests that their removal proceeds essentially by salt formation between the basic amino group and the acid form of the exchanger. This conclusion is substantiated by the fact that static studies of the absorption of glycine from solutions containing varying amounts of hydrochloric acid show decreasing removal as the pH is lowered, and by the fact that the calcium and sodium forms of cation exchangers either did not react or reacted slightly with amino acids. Addition of formaldehyde to the amino acid solutions had little effect upon their reaction with the hydrogen form of the exchangers. Adsorption of the nine amino acids by the hydrogen exchangers was studied by static methods also. Previous equations for treating the data are not entirely applicable — in part because of the diverse acidic groupings and consequent inhomogeneity of the exchangers. Anion exchangers — Amberlite IR-1 and De-Acidite — react with dicarboxylic but not with monocarboxylic monoamino acids. Thus, a separation of these two groups of acids may be expected. The basic amino acid hydrochlorides are not removed by the anion exchangers.

PLYWOOD MASTS EXPEDITE FIELD RADIO INSTALLATION. Aero Digest *45*, 118, 220 (May 15, 1944). Long tubes made of wood veneers bonded with synthetic resin are used as portable radio masts, 75 ft. in height. The mast section for one 75-ft. mast packed for shipment weighs 152 pounds. The guy wires and hardware weighs 121 pounds. A chest for spare parts weighs 45 pounds. Thus the total weight of the packed mast is 318 pounds. Three men can erect the mast in 30 minutes.

CONVAIR'S NEW TOOLING PLASTIC. T. A. Dickinson. Aero Digest *45*, 100–1, 220 (June 1, 1944). A filled thermosetting cast phenolic plastic for making hydropress form blocks, stretch forms, sinking dies, drill jigs, checking fixtures and lathe fixtures is described.

Coatings

PHYSICAL CHEMISTRY OF LACQUERS. X. LACQUER SOLVENTS. R. R. Schäfer. Fette u. Seifen *50*, 227–41 (1943); Chem. Ab. *38*, 2835 (June 10, 1944). Molecular arrangement, results of x-ray studies, shape of molecule, association, melting point, boiling point and evaporation mechanism of organic solvents are reviewed. Ninety-two references are given.

MACHINES AND METHODS FOR PLASTIC COATINGS. J. B. Cleaveland. Textile World *94*, 74–6 (Mar.), 90–1 (May), 107, 111 (June), and 81, 83, 85 (July 1944). The various methods for applying plastic coatings to fabrics are described and illustrated. Knife-coating techniques include the use of knife-spreading, knife-blanket and knife-roller coating machines. Roller-coating techniques include the use of transfer-roll, calender, reverse-roll and etched-roll coating machines. Other methods are extrusion, brush, dip and spray coating. The applications and limitations of each type of coating are described. The last article discusses the operation of coating machines and safety precautions.

SOLUBILITY OF CERTAIN PLASTICIZERS IN LIQUID AMMONIA. P. C. Scherer and E. O. Sternberg. Rayon Textile Monthly *25*, 143–5 (Mar. 1944). With a view to the possible application of liquid ammonia as a solvent for cellulose derivatives in the production of films and filaments, the solubility of various plasticizers in this solvent was determined. A technique for making such measurements is described. The phosphates appear to be only slightly soluble; in all cases some tendency toward reaction with the solvent was noted. The simple aliphatic esters of phthalic acid, methyl, ethyl, butyl, and hexyl phthalates were all soluble and appeared quite stable toward the solvent. The solubility decreased rapidly with increasing length of aliphatic chain. Diphenyl phthalate reacted vigorously with the solvent with apparent ammonolysis of the ester linkages to give phenol and phthalamide which, on heating, forms phthalimide. The glycols appeared to be stable toward the solvent and were soluble. Glycol butyrate was about twelve times as soluble as glycol hexoate. All of the glycollates tested appeared to react with the solvent and in one case, butyl phthalyl butyl glycollate, butyl alcohol was isolated from the products. Both sulfonamides which were tested seemed to be practically infinitely soluble and quite stable whereas dihydromethyl abietate was soluble only to a very slight extent. Castor oil, dehydroacetic acid and polyethylene glycol were also tested, but since these were all mixtures, it was impossible to obtain a satisfactory value for the solubility.

COATING NYLON FABRICS FOR MILITARY USE. Textile World *94*, 112–13 (Apr. 1944). Difficulties encountered in coating light-weight nylon fabric are described and methods of eliminating these troubles are given. Recurring tight and slack sections and the high static charges developed are the principal difficulties; others are slippage, wrinkling and curling.

U. S. Plastics Patents

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 10 cents each

RESIN. R. B. Du Vall and E. F. Grether (to Dow Chemical Co.) U. S. 2,350,326, June 6. A resinous condensation product is formed by heating a mixture of parahydroxy benzoic acid and a polyhedric alcohol at 150 to 225° C.

CELLULOSIC FILMS. J. V. Bauer and D. M. Hawley (to Stein Hall Manufacturing Co.). U. S. 2,350,336, June 6. Corrugated paperboard assemblies are made by treating opposite sides of a paper-corrugating medium with acid and water-soluble urea-formaldehyde reaction product, thus rendering it waterproof, and corrugating after the reaction has substantially ceased.

MOISTURE PROOFING. J. A. Mitchell (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,350,366, June 6. Sheet material is coated with a composition of wax and cyclicized rubber containing phenol-formaldehyde-piperazine resin.

CELLULOSE ESTERS. H. Dreyfus (to Celanese Corp. of America). U. S. 2,350,391, June 6. Mixed cellulose esters are prepared by esterifying a cellulose ester with the anhydride of another organic acid.

RESINS. W. A. King (to Allied Chemical and Dye Corp.). U. S. 2,350,400, June 6. Styrene is substantially polymerized at 125° C. in the presence of a solvent, the excess monomer being removed with most of the solvent by distillation.

JEWEL INLAY. W. P. Schoder and J. P. Ruth. U. S. 2,350,421, June 6. Inlaid jewels are prepared by molding into transparent thermoplastic material.

POLYOLEFIN. L. A. Mikeska and E. Arundale (to Jasco Inc.). U. S. 2,350,317, June 6. A cyclic acetal substituted with halogen, alkyl, aryl, alkenyl, aralkenyl, alicyclic, aralkyl, alkaryl, halo-alkyl, alkoxy, aryloxy, carbaloxy or hydroxy radicals is refluxed with an aqueous acidic solution and the resulting polymer removed.

INJECTION MOLDING. G. Smith (to Reed-Prentice Corp.). U. S. 2,350,539, June 6. A device for regulating temperature in injection-molding apparatus.

PLYWOOD. M. F. Crouet (to Alien Property Custodian). U. S. 2,350,729, June 6. A plywood structure comprising alternate impregnated and unimpregnated wood plies, the former containing a polymerizable resin.

MOLDING. G. Kirchner (to Alien Property Custodian). U. S. 2,350,770, June 6. Waste celluloid material is tumbled in an atmosphere charged with vapors of solvent prior to adding to a compression chamber and injecting under pressure into a mold.

POLYAMIDES. W. Wehr (to Alien Property Custodian). U. S. 2,350,851, June 6. Foils, tubes, rods, etc., are produced from polyamides by soaking in a low-boiling aliphatic alcohol at 30° C. and fusing the mass at raised temperature.

ADHESIVE. R. T. Argy and C. W. Foss (to Carborundum Co.). U. S. 2,350,861, June 6. An abrasive belt of coated web material is joined at the ends by an adhesive mixture of a water-soluble urea-aldehyde resin and an alkyd modifier.

UREA-FORMALDEHYDE RESINS. H. Hönel (to Alien Property Custodian). U. S. 2,350,894, June 6. Resinous products are produced by reacting urea with aqueous formaldehyde solution, vacuum distilling and heat treating the resulting syrup with an alcoholic substance.

POLYAMIDES. L. F. Salisbury (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,351,074, June 13. A polyamide composition is prepared from a mixture of polyamides by heating above the melting points of each substance until polymerization occurs.

VINYLIDENE-CHLORIDE POLYMER. E. C. Britton and F. L. Taylor (to Dow Chemical Co.). U. S. 2,351,102, June 13. Vinylidene-chloride polymer plasticized with a methoxyl-, chlorine- or phenyl-substituted alpha phenyl ethyl phenol.

ACETYLENE POLYMERS. A. M. Collins (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,351,108, June 13. A film-forming material is prepared by polymerizing non-benzenoid polymers of acetylene in the presence of a mercaptan.

ETHYLENIC POLYMERS. W. E. Hanford (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,351,120, June 13. The product of the reaction between solid polymers of carbon monoxide and an ethylenic compound and an aldehyde in the presence of an alkaline catalyst.

COATED FABRIC. W. Whitehead (to Celanese Corp. of America). U. S. 2,351,174, June 13. A fabric base of yarns containing a cellulose ether or ester, coated with a composition containing a similar cellulose derivative.

COATED FABRIC. (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,351,182, June 13. An open weave fabric, the interstices of which are closed with a composition of polyvinyl acetate, applied in a solution of ethyl acetate and ethyl alcohol, the surface of the film being then coated with a thermoadhesive composition.

SUPERPOLYAMIDES. O. Herrmann, A. Wunderer and H. Böttger (to Alien Property Custodian). U. S. 2,351,208, June 13. Films of superpolyamides are cast from solution on a support, the dried film is removed, curling being prevented by treating the surface with a swelling agent which is subsequently evaporated.

HELMET LINER. G. A. Shroyer, L. P. Gould and R. E. Moule (to General Motors Corp.). U. S. 2,351,235, June 13. A helmet liner is prepared by impregnating fabric with a thermosetting resin and curing under pressure in a mold.

CELLULOSE DERIVATIVES. R. D. Freeman and R. C. Anthonisen (to Dow Chemical Co.). U. S. 2,351,258, June 13. Water-soluble alkali metal salts of carboxyalkyl cellulose are recovered by acidifying to pH 1, neutralizing with an alkali and adding a monohydric alcohol to precipitate the salt which is then removed by filtration.

PLASTIC. H. M. Sonnichsen (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,351,301, June 13. An elastic rubber-like molded article composed of an esterified vinyl alcohol plasticized with a high-boiling fatty acid polyester.

RUBBER HYDROCHLORIDE. G. D. Mallory (to Wingfoot Corp.). U. S. 2,351,350, June 13. Rubber hydrochloride films are laminated under heat and under pressure.

SOUND RECORD. W. R. Collings (to Dow Chemical Co.). U. S. 2,351,600, June 20. A sound record comprising a supporting base and a laminated surface

film which is comprised of plasticized ethyl cellulose and bonded to the base by means of an ethyl cellulose adhesive.

CONDENSATION PRODUCT. G. F. D'Alelio (to General Electric Co.). U. S. 2,351,602, June 20. The reaction product of urea, melamine, formaldehyde and monochloroacteamide.

INJECTION MACHINE. L. P. McGowen (to Ford Motor Co.). U. S. 2,351,774, June 20. A rotating table upon which are mounted individual molds which are successively brought into contact with an injecting orifice.

TERPENE RESIN. A. L. Rummelsburg (to Hercules Powder Co.). U. S. 2,351,786, June 20. A terpene polymer is prepared by polymerizing an acyclic terpene in the presence of hydrogen fluoride at a temperature between —20 and 200° C.

MINERAL WOOL. W. M. Bergin and A. L. Simison (to Owens-Corning Fiberglas Corp.). U. S. 2,351,802, June 20. Mineral fibers are treated with an aqueous solution of phenol- or urea-formaldehyde condensate and an oleaginous lubricant incompatible with the resin.

CELLULOSE ESTERS. I. Miller. U. S. 2,351,866, June 20. An injection-molding composition of cellulose ester and thermally-active plasticizer is prepared by kneading under high pressure.

COATING. E. M. Bright (to Plastic Veneering, Inc.). U. S. 2,351,919, June 20. A pattern having a wood core and coated with cellulose butyrate in volatile solvent by spraying, is placed until dry in a curing compartment having dehydrated air and subatmospheric pressure.

CAST RESINS. E. Dreher (to Alien Property Custodian). U. S. 2,351,937, June 20. Cast resinous objects are prepared from an alkaline catalyzed phenol-formaldehyde condensate from which water has been removed and which is neutralized with an organic soap, by heating at 100° C. in a mold.

RESINS. B. Habraschka (to Alien Property Custodian). U. S. 2,351,958, June 20. A heat-hardenable resin is prepared by condensing ortho-cresol and formaldehyde to an intermediate stage and thereafter condensing in the presence of tricresyl phosphate and a fatty acid.

CELLULOSE ESTERS. A. Schuller and R. Tritsmans (to Alien Property Custodian). U. S. 2,352,022, June 20. Lower fatty acid cellulose esters are stabilized by washing to remove excess acid and by digesting at 50 to 140° C. with a liquid aromatic hydrocarbon.

RESINS. L. H. Bock and A. L. Houk (to Rohm and Haas Co.). U. S. 2,352,-070-1, June 20. The reaction products of formaldehyde and a *N*-polyalkylene polyaminoamide of malonic acid having a reactive methylene group and the reaction product of formaldehyde and a *N*-aminoalkyl amide of malonic acid.

LACQUER. L. Auer (to Ridbo Laboratories, Inc.). U. S. 2,352,173, June 27. A lacquer comprising nitrocellulose, a plasticizer and a non-volatile rosin material prepared by heating rosin in the presence of a decarboxylation agent.

CELLULOSE ESTERS. G. D. Hiatt and J. Emerson (to Eastman Kodak Co.). U. S. 2,352,261, June 27. Dicarboxylic acid esters of cellulose are prepared by heating a mixture of a cellulose ester or ether and a dicarboxylic acid anhydride.

RESINS. J. Kleine (to Alien Property Custodian). U. S. 2,352,328, June 27. Fibers, foils, ribbons, etc., are prepared from the hydrogenation product of paraffins having chain lengths of 400 chain-carbon atoms.

CONDENSATES. H. Hopff, A. Weickmann and R. Kern (to General Aniline and Film Corp.). U. S. 2,352,387, June 27. Condensation products of hexamethylene diamine and monomeric carbonyl compounds such as aldehydes and ketones.

FOOTWEAR. F. Dawson (to Compo Shoe Machinery Corp.). U. S. 2,352,520, June 27. A sole is applied by placing a plastic shank on the bottom of a shoe, placing the sole upon the bottom with cement, pressing against the bottom and shank piece, and subjecting to an electrostatic field — thus melting the shank piece to the cement.

VINYL RESINS. W. J. R. Evans (to Imperial Chemical Industries Ltd.). U. S. 2,352,525, June 27. Polyvinyl chloride is dissolved in carbon tetrachloride and tetrachloroethane and subjected to chlorination.

PLYWOOD TUBING. P. R. Goldman (to Plymold Corp.). U. S. 2,352,533, June 27. Wooden strips are wrapped spirally around a removable mandrel, coated and impregnated with a heat-reactable resin and the resin is cured with heat under pressure.

COATING. J. J. Waters (to Etched Products Corp.). U. S. 2,352,579, June 27. Pyroxylin lacquer is rendered adhesive to zinc surfaces by adding zinc dust to the lacquer, allowing it to settle and decanting the solution from the zinc.

COMPOSITE STRUCTURE. A. E. Juve (to B. F. Goodrich Co.). U. S. 2,352,637, July 4. A structure comprising layers of a rigid base, halogenated rubber, a vulcanized polymerized haloprene and a plasticized polyvinyl halide, the structure being prepared by vulcanizing the haloprene.

COMPOSITE STRUCTURE. B. S. Garvey and D. E. Henderson (to B. F. Goodrich Co.). U. S. 2,352,705, July 4. A structure comprising layers of a rigid base, halogenated rubber, a vulcanized copolymer of butadiene and an unsaturated nitrile, and a plasticized polyvinyl halide, the whole being bonded by vulcanizing the copolymer.

SHAPED ARTICLE. W. H. Markwood, Jr. (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,352,725, July 4. A shaped body composed of a synthetic linear polyamide having a pearlescent effect due to inclusion of minute enclosed voids, said polyamide comprising the reaction product of a monoaminocarboxylic acid and a mixture of a diamine and a dibasic carboxylic acid.

BAMBOO IMPREGNATE. H. D. Shannon (to Bakelite Corp.). U. S. 2,352,740, July 4. The cell walls of bamboo are impregnated with a phenol-aldehyde or urea-aldehyde by soaking in water until the cells and cell walls are impregnated with water, and thereafter soaking in an aqueous solution of the resin until the cells are impregnated with the resin, after which the resin is cured.

COATING. W. Whitehead (to Celanese Corp. of America). U. S. 2,352,747, July 4. Fabric is coated with a plasticized cellulose derivative.

COATING APPLICATION. B. Wills (to Lock Joint Pipe Co.). U. S. 2,352,749, July 4. An apparatus for applying a plastic coating solution to a surface.

BIURET RESIN. E. D. McLeod (to Arnold, Hoffman and Co., Inc.). U. S. 2,352,796, July 4. A water-soluble resin is prepared by reacting equal quantities of boric acid and a biuret.

YARN. J. E. Pierce (to Visking Corp.). U. S. 2,352,861, July 4. Strands of vinylidene-chloride polymer are gathered into a cluster and twisted while stretching in order to effect crystallization, thereby giving a permanent set.

RESINS. G. F. D'Alelio and J. W. Underwood (to General Electric Co.). U. S. 2,352,943-4-5, July 4. Reaction products of substituted triazine, diazine and triazole derivatives with aldehydes.

ORGANOSILICON POLYMER. E. G. Rochow (to General Electric Co.). U. S. 2,352,974, July 4. A polymeric chemical compound comprising monovalent saturated aliphatic and divalent aryl radicals linked to silicon atoms, each divalent radical being linked to two silicon atoms.

BOOKS AND BOOKLETS

Write directly to the publishers for these booklets. Unless otherwise specified, they will be mailed without charge to executives who request them on business stationery. Other books will be sent post-paid at the publishers' advertised prices.

Plastics

2nd Edition
by J. H. DuBois
American Technical Society, 850 East 58th St., Chicago, 1943
Price $3.75 — 435 Pages

Three new chapters have been added to this book which is written for actual users of plastics. These concern synthetic rubber, low-pressure laminating, and trends and developments. They serve to bring the book up to datc on new materials, processes and applications during the war period.

There have been minor revisions of the earlier chapters. A section on vulcanized fibre has been added to the chapter on Other Plastics and a table of general properties and uses for molded plastics is included in the book.

From the consumer's viewpoint the book is rather sketchy in its coverage of specifications for plastics. It fails to mention or describe the pioneering work which is being carried on by the American Society for Testing Materials to establish quality standards for plastic materials. However, like its predecessor which was reviewed in the Sept. 1942 MODERN PLASTICS, this book is recommended for engineers, designers and students who want an introduction to plastics. G.M.K.

Experimental Stress Analysis

Edited by C. Lipson and W. M. Murray
Addison-Wesley Press, Inc., Cambridge, Mass., 1943
Price $3.00 — 156 Pages

The seventeen papers presented at the seventeenth Eastern Photoelasticity Conference and Experimental Stress Symposium are presented in full in this publication. The style and quality of illustration used in the printing of this important technical material is especially noteworthy. The name of the organization was changed to the Society for Experimental Stress Analysis and this book is Vol. 1, No. 1, of their transactions. G.M.K.

Plastic Horizons

by B. H. Weil and Victor J. Anhorn
The Jacques Cattel Press, Lancaster, Pa., 1944
Price $2.50 — 169 Pages

What is the difference between a plastic and a resin? How do the various plastics differ and how are they formed? These are a few of the questions intelligent laymen are asking today. The answers to these queries and many others are set forth clearly and simply in the introductory chapters of this book.

Because of the authors' keen awareness of the needs of the general reading public, a happy balance has been maintained between the factual background, which includes just enough chemical definition to clarify plastic structures, and later chapters dealing with economic trends, plastics in the present war and future possibilities.

Although they do not indulge in any glowing fancies, the authors predict that postwar manufacturers will have gained new confidence from their recent experiences and embark on the production of promising new plastics. Moreover, the increasing awareness of what plastics can do should pave the way for wider, more receptive markets. A convenient list of names, chemical types and manufacturers of familiar plastics and related materials is appended at the end of the book.

Synthetic Adhesives

by Paul I. Smith
Chemical Publishing Co., 26 Court St., Brooklyn, N. Y.
Price $3.00 — 125 pages

Various formulas and application data are presented by the author for phenolic, urea, cellulose, vinyl, acrylic, alkyd and rubber cements. The uses and advantages of each type of synthetic adhesive are tabulated. Particular attention is given to the resins employed in the manufacture of aircraft plywood and compreg. G.M.K.

★ "PLASTICS — THE PRESSURE Processing of Synthetic Resins," released by The Hydraulic Press Manufacturing Co., Mt. Gilead, Ohio, is a bulletin written expressly for postwar planners, particularly those who have had little or no association with the plastics industry. Written in terms easily understood by the layman, this brochure defines thermosetting and thermoplastic resins and the 4 methods of molding them. Diagrams show how the materials are compounded, process pictures give details of the molding and other photographs show the finished product.

★ 3-M ADHESIVE DATA FOR sealing, insulating, adhering, sound-deadening, coating, packaging and many other applications, are given in an 8-page booklet issued by Minnesota Mining and Mfg. Co., St. Paul, Minn.

★ FINISHES DIV., E. I. DU PONT de Nemours and Co., Inc., Wilmington, Del., has made available a 20-page booklet on "Three-Dimensional Seeing, the Science of Color and Light for Better Vision in Industry." This colorfully illustrated brochure contains information culled from many color-conditioning installations, and a "Safety Color Code for Industry" recommending the use of specific color symbols to denote specific hazards and safety equipment.

★ THE PLASTICS DIVISION OF Carbide and Carbon Chemicals Corp., New York City, has released a new brochure containing information on Vinylite plastics elastomeric compounds. A summary of the standard methods of bonding Vinylite compounds is followed by suggestions for standard combinations. A list of suppliers of chemicals and resins is included in the pamphlet.

★ SPECIFICATIONS FOR 28 IN. vertical hydro-tel milling machines produced by Cincinnati Milling and Grinding Machines, Inc., Cincinnati, Ohio, are itemized in booklet M-1284 of recent issue. These machines combine maximum rigidity of structure, almost effortless manipulation, efficient spindle drive and independent power feeds for table, cross slide and vertical spindle carrier. The brochure illustrates four basic methods of construction of these machines, and lists the outstanding features and specifications of each method.

★ THE SOCIETY OF THE PLASTICS Industry, 295 Madison Ave., New York City, has compiled a booklet on "Typical Labor Contract Provisions Prevailing in the Plastics Industry." Phases covered are: recognition clauses, hours and overtime clauses, vacation clauses, war seniority, seniority, adjustment of grievances, leave of absence, safety and health, and renegotiation of wages.

★ A TECHNICAL BOOKLET ON Bakelite cast-resin plastics has been published by Bakelite Corp., New York City, describing characteristics, properties and the wide range of applications of these cast resins. Also included is information on the machining and finishing steps required to fabricate these resins into finished products.

Problem Ideas Molded . . . in PLASTICS

That product idea of yours which some infinitesimal "bug" may still be stymying is likely to find its solution in the hands and minds of Tech-Art engineers. Reducing what appears to be insoluble plastic problems to workable plastic realities is one of Tech-Art's specialties. Tech-Art's credo holds that proper engineering of any product is the primary requisite. Sound engineering plus precision mold building and the proper selection of plastic materials are three essentials of successful production. The fourth and fifth are adequate modern equipment and technical molding skill. These are the five essential factors which have been responsible for so many Tech-Art Plastic Success Stories.

Another Plastic Success Story

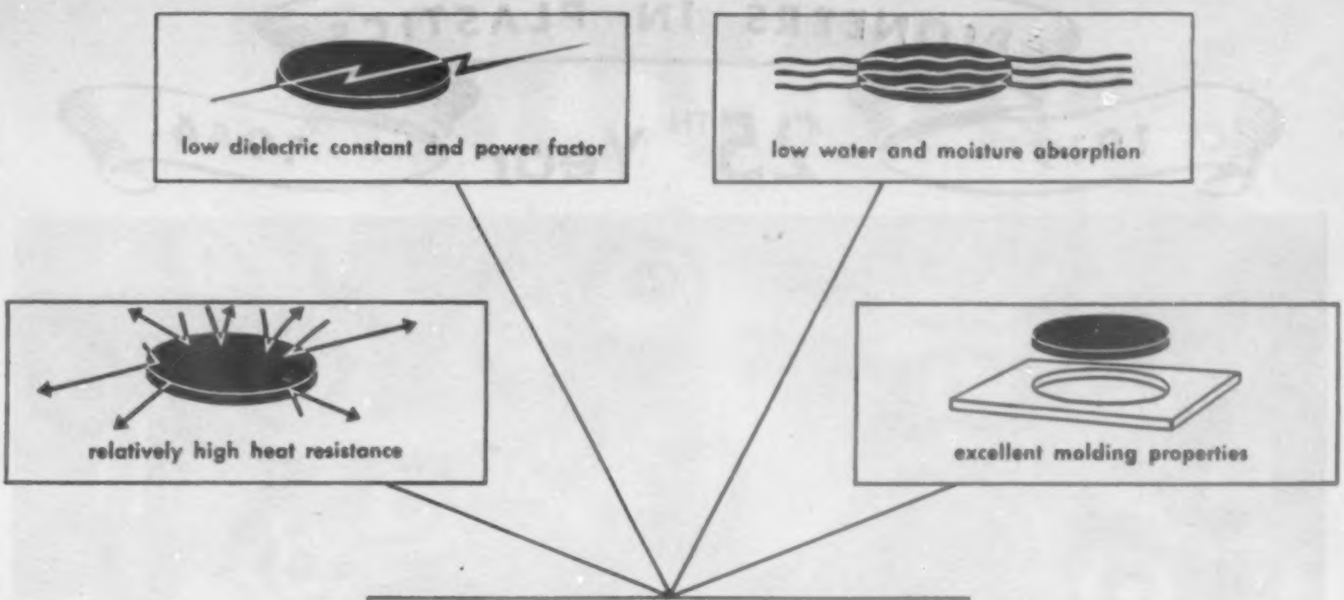
This skillfully designed rheostat base was brought to Tech-Art to mold by one of America's leading Electrical Instrument makers. Close assembly of the many metallic inserts involved in each small unit was obviously a necessity, yet, no current leakage could be permitted. Only ultra-precision mold building, only the finest of molding equipment, only the highest degree of molding skill could have turned these units into another plastic success story.

Quad Erat Demonstrandum

TECHNICAL NOTES: *Actually eleven separate metallic inserts in close, but non-contacting assembly were molded into each of these units requiring a complete flow of non-conducting plastic material into each of the interstices. Each unit had to be carefully tested to fifteen hundred volts.*

36th Ave. and 41st Street • LONG ISLAND CITY, N. Y. • Tel. AStoria 8-6050-1
SUCCESSORS TO BOONTON RUBBER MANUFACTURING COMPANY
PIONEER PLASTIC MOLDERS . . . Established 1891

TECH-ART PLASTICS COMPANY



NEW RESINOX

for electrical applications

HERE is welcome news to every molder with an eye on war and postwar electrical markets:

> **A new, mica-filled Resinox molding compound with outstanding advantages in insulating parts for medium and high frequency apparatus is now available for military and naval end uses.**

The new compound, Resinox 7934, is based on a new phenolformaldehyde resin developed by Monsanto plastics research laboratories. It combines (1) a low dielectric constant and power factor with (2) low water and moisture absorption, (3) relatively high heat resistance and (4) improved molding properties.

Specifically, dielectric constant at 1 K.C. is 4.35 to 4.50; at 1 M.C. it is 4.20 to 4.50. Power factor at 1 K.C. is 0.015 to 0.017; at 1 M.C. it is 0.0080 to 0.0085.

Water absorption after 24 hours immersion is only 0.030% by weight.

Resinox 7934 can be molded with greater ease and economy than any mica-filled phenolic compounds yet developed, giving compression molders an excellent chance at many electronic applications which other phenolics could not fill.

For full details, write or wire: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

RESINOX 7934

PROPERTIES OF THE MOLDING POWDER:

Particle Size: Ground to pass U. S. S. 16 mesh screen
Apparent Density: 0.75 to 0.85 grams per cc.
Bulk Factor: 2.07 to 2.35
Pourability: Good
Preforming Characteristics: May require special handling
Flow: 7 to 14

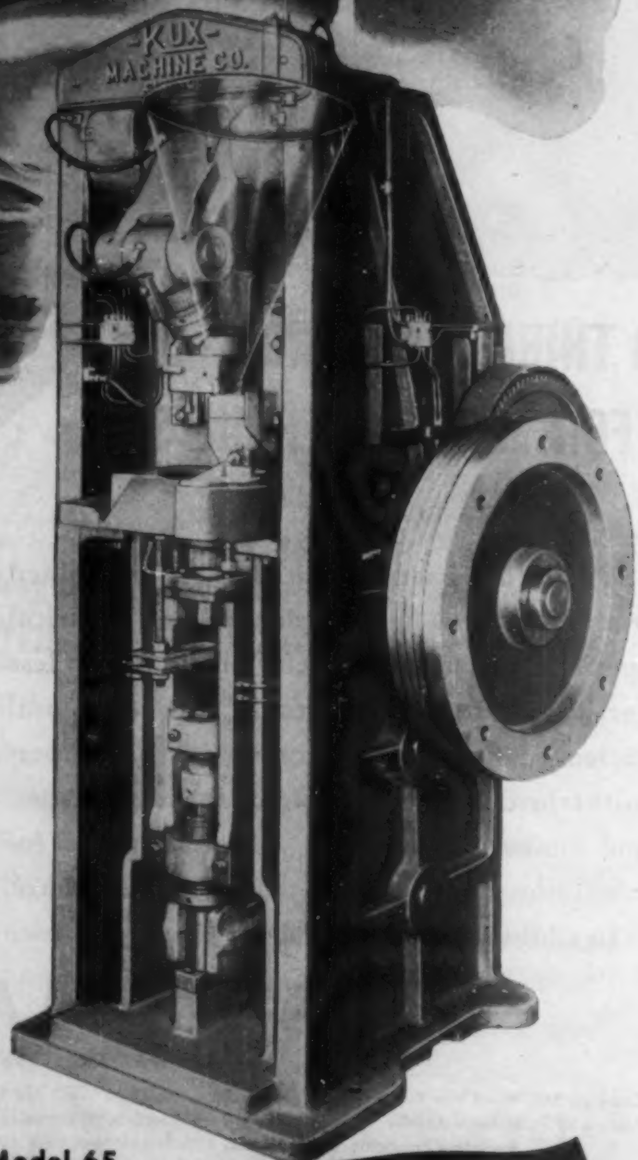
PROPERTIES, MOLDED:

Specific Gravity: 1.76
Weight per Cubic Inch: 28.9 grams
Flexural Strength: 9,000 to 10,000 lbs. per square inch
Maximum Deflection: 0.024 inches
Tensile Strength: 6,000 lbs. per square inch
Impact Strength: 0.35 to 0.40 ft.-lbs. per inch of notch
Dielectric Strength at 60 Cycles:
S/S-350 to 400 volts per mil
S/T-400 to 450 volts per mil
Dielectric Constant: 1 K.C. 4.35 to 4.50
1 M.C. 4.20 to 4.50
Power Factor: 1 K.C. 0.015 to 0.017
1 M.C. 0.0080 to 0.0085
Water Absorption: 0.030 percent by weight (24 hours)
Shrinkage: 0.0025 to 0.0035 inch per inch

The broad and versatile family of Monsanto Plastics includes: Lustron polystyrenes • Cerex heat resistant thermoplastics • Vinyl acetals Nitron cellulose nitrates • Fibestos cellulose acetates • Resinox phenolics Resimene melamines. Forms in which they are supplied include: Sheets Rods • Tubes • Molding Compounds • Industrial Resins • Coating Compounds • Vuepak rigid, transparent packaging materials.

MONSANTO PLASTICS

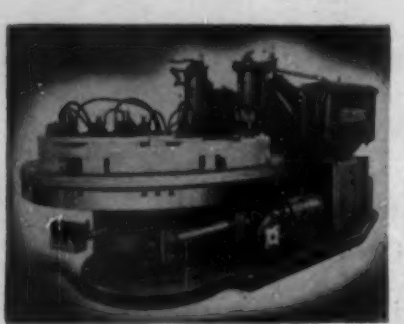
SERVING INDUSTRY...WHICH SERVES MANKIND


KUX
MACHINE CO.

NEW MACHINERY AND EQUIPMENT

★ NUMBER 2-P THERMEX, DEsigned by the Thermex Div., Girdler Corp., Louisville, Ky., to meet the demand for automatic high-frequency equipment for preheating of plastic preforms, is said to have an output in excess of 3400 Btu's per hour. Operating at a frequency of 25 to 30 megacycles, the model uses a 230-volt, 60-cycle, single-phase current. Since it is completely automatic, the unit need only be plugged in, loaded and unloaded. A red light on the thermex flashes to indicate to the operator the completion of the prescribed time.

★ DESIGNED TO BRING THE ADvantages of high-speed, automatic shaping methods to the fabricating of large pieces,



the Onsrud WB-112 is at once the largest and the newest of the automatic shapers manufactured by Onsrud Machine Works, Inc., Chicago, Ill. Under direct drive of a $12^1/_2$-hp., 3-phase, 120-cycle electric motor, each cutter spindle of this double arm machine rotates at 7200 r.p.m. The cutter head assembly, which tilts in one plane to either side of vertical up to a maximum of 10°, is controlled automatically, and can be varied by the use of special templates or pattern setups. The unit will handle work that is up to 112 in. in diameter, 79 in. square, or 97 in. in length.

★ KNOWN AS RCA MODEL 2-B electronic power generator, the new RCA automatic electronic "oven," manufactured by RCA Victor Div., Radio Corp. of America, Camden, N. J., is said to combine ruggedness, portability, ease of installation, safety and simplicity of operation with established technical advantages of electronic heating. This unit has an automatic heating timer and is provided with such safety features as a control panel, placed for convenience just below the lid. It is understood to deliver up to 2000 watts of power, the ultra-high operating frequency designed to insure rapid heating of a wide variety of materials without danger of arc-over between plates. In addition to its safety features for protection of the operators, the machine itself is protected by an r-f filter inside the cabinet which guards against radio-interference radiation by the power circuits.

★ TO MEET SPECIALIZED PROBlems presented by the unusual characteristics of many new materials, Continental Machines, Inc., Minneapolis, Minn., is manufacturing a high-speed sawing machine. Known as the DoALL Zephyr, the machine can shape 104 basic materials through its control of high speeds, rigid construction and the use of all-purpose, narrow, precision-cutting band saws. Speed ranges, controlled by a variable speed pulley, are from 1500 to 10,000 ft. per minute. Included in the standard equipment are a 10-hp. variable speed drive, a 30 by 30 in. work table, and a secondary table extension, 17 by 20 inches. Various kinds of band saws such as spring-tempered, metal-cutting saws may be used as well as DoALL Buttress tooth saws.

★ SURFACE PYROMETERS WERE developed by the Cambridge Instrument Co., Inc., New York, N. Y., to fill a need for quick and accurate temperature determinations in the plastics, rubber, paper, textile and electrical fields and in many other industries where the temperature of moving and still, curved and flat surfaces are desired.

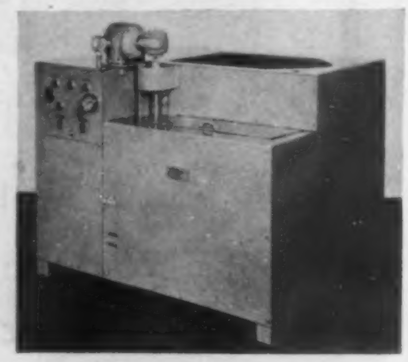
Roll, extension, mold and needle models have been designed to meet special needs. The mold model is being widely used in the plastics industry where it is employed to determine the surface temperature of molds. The needle pyrometer is finding wide application in determining the temperature of preforms heated by high-frequency current.

★ TO MEET THE DEMAND FOR A machine with greater coolant capacity and more rigid construction for greater grinding accuracy, Porter-Cable Machine Co., Syracuse, N. Y., has released the new Model AG-8 wet belt surfacer. This machine, equipped with a 35-gallon self-contained recirculating pump system, is said to be capable of being held to close tolerances even by inexperienced operators. Other features include a conveniently located waste cleanout drawer, a "joggle" type switch for easier tracking of belts; a higher table, a flexible tube and greater platen grinding area. The company claims that many hazards such as heating, warping, discoloring, flowing and chipping of material being ground are being eliminated.

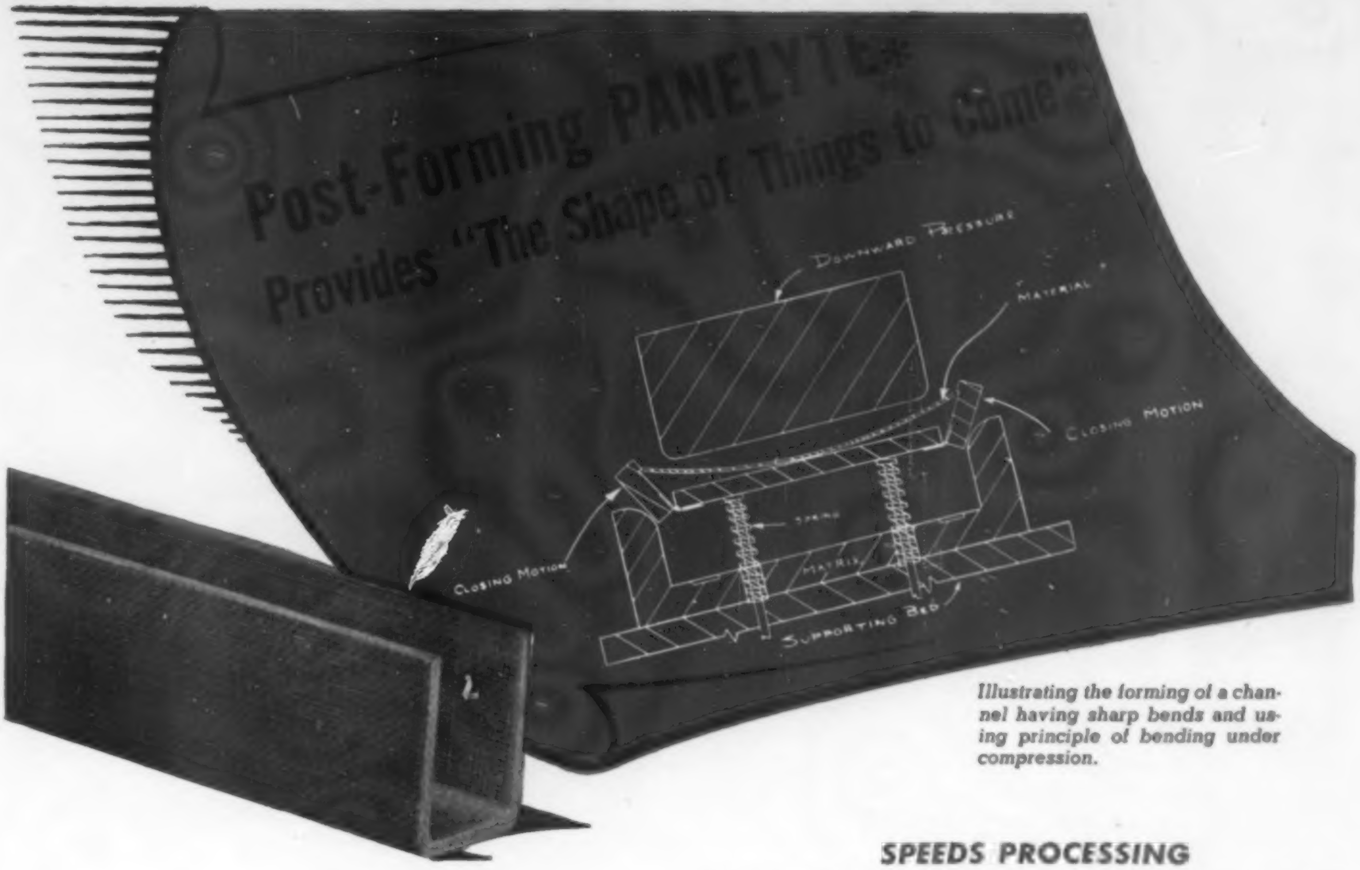
★ PLASTIC MOLDING MACHINery Division of Improved Paper Machinery Corp., Nashua, N. H., is manufacturing 2- and 4-oz. injection molding machines, built as self-contained units and operating either manually or automatic single-cycle. The heating cylinders are said to be so inexpensive that extra units may be carried—effecting savings of considerable material when changes of color or material are required. Dies are clamped by a toggle specially designed to give the "follow-up" which is gained from hydraulic clamping.

★ A NEW MACHINE, USED FOR stamping letters and figures on plastic nameplates with color roll leaf, is being manufactured by Numberall Stamp & Tool Co., Huguenot Park, Staten Island, N. Y. This machine works on the same principle as a typewriter, advancing one space at a time and doing rapid work with even spacing and perfect alignment. It is furnished with an electrical heating element which can be plugged into any electric light outlet and regulated by a rheostat. Characters of various sizes are available for this machine.

★ AN ETHYL CELLULOSE MELTing and dipping tank, which is said to incorporate all the requirements set up by the manufacturers and by Ordnance for control of this material, has been designed and built by Youngstown Miller Co., Sandusky, Ohio. Indirect heat is employed, and thermostatic control maintained over both the heat exchange me-



dium and the plastic. Before entering the dip tank, the plastic is melted and preheated to proper temperature for dipping. During immersion, the material is circulated in such a way that it maintains constant level in the tank. Surface film and air bubbles are removed as they arise. The above unit, Model 60, has a capacity for 100 lb. of plastic per hour. Other units are also available which are capable of either smaller or larger capacities.



Illustrating the forming of a channel having sharp bends and using principle of bending under compression.

Today . . . design engineers can "get ideas across" in physical form quickly, easily and economically with post-forming Panelyte grades.

SAVES COST OF METAL DIES

Channels, boxes and an unlimited variety of more intricately shaped objects with compound curvatures or sharp draws may be molded from flat plastic sheets utilizing inexpensive forming dies of cast phenolic, laminated phenolic or hardwood. No elaborate tooling, heavy equipment or high pressures are required.

SPEEDS PROCESSING

For forming, arbor presses, fast-acting hydraulic, pneumatic toggle or cam-acting presses are all satisfactory. *Hot molds are not needed* – merely heat Panelyte *rapidly* to degree higher than in original manufacture, mold and allow partial cooling. Hot oil, metal baths, infra-red lamp ovens are superior heating agents.

1001 POSSIBLE APPLICATIONS

Only a fraction of the weight of the metals they replace, these fully cured thermo-setting sheet plastics offer many "firsts" in specific plastic fabrication. Write for Engineering Bulletin on Panelyte post-forming grades and samples.

PANELYTE *the structural plastic*

PANELYTE DIVISION
ST. REGIS PAPER COMPANY
230 PARK AVENUE
NEW YORK 17, N. Y.

Sales Offices: Atlanta, Boston, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Kansas City, Los Angeles, Montreal, New Orleans, St. Louis, St. Paul, San Francisco, Seattle, Syracuse, Toronto, Trenton, Vancouver

*

MASS PRODUCTION OF SHEETS, RODS, TUBES, MOLDED FORMS, FABRICATED PARTS

WASHINGTON ROUND-UP

R. L. VAN BOSKIRK, Washington Editor

Experimental model order

So far as the plastics industry is concerned, the key sentence in Priorities Regulation No. 23 which authorized production of postwar experimental models, seems to be part of Par. (a) Section 944.44, which says: "Nobody needs to read this regulation unless he wants to make experimental models of an article which cannot be made under existing orders and regulations."

The plastics industry has had the privilege of making experimental models for some time past. But plastics molders' and laminators' customers, who manufacture refrigerators, office machinery, kitchen equipment, electrical equipment, washers, sweepers, etc., and can now get metal for experimental models, will want to know about availability of plastics parts for those models. If the molder is not ready to give this information, those experimental model parts formerly in plastic may possibly go to some competitive material and stay in that material for later production.

No change in present Government regulations affecting plastics processors is necessary to meet these demands. Restrictions on molds were lifted when L-159 was revoked. Metal for inserts on experimental models should be comparatively easy to obtain under the new regulations. However, the average molder should have little difficulty finding enough metal around his shop to take care of the small amount needed for an experimental model.

Practically all plastics orders contain provisions which make raw materials available for small orders or experimental requests.

Over and above these printed orders, there is the Plastics Branch's liberal policy of allowing practically all legitimate requests for small amounts of material when the applicant gives bona-fide evidence that it is strictly an experimental job. Notice is directed to this procedure for allowing raw materials for experimental purposes by the allocation method. It is in direct contrast to the system employed by the metals people who demand that the applicant tell WPB specifically what he wants to make.

Outlook for molds and machines

The matter of obtaining molds for experimental models has not been changed since revocation of L-159. No molder is forbidden to order or make any type of mold he wishes, but these molds must be made according to the priority rating that they carry.

In so far as machinery is concerned, there is no change in the plastics picture. There are only 11 injection machines available for allocation the third quarter and 87 for the fourth quarter. These will be allocated preferably to those molders whose war work is most pressing.

There has been considerable talk about the 87 injection machines listed for allocation during the fourth quarter. One man wanted to know where they were coming from, since it was recently reported that manufacturers could produce only 8 a month. The answer is that producers have diverted manpower and materials from other machines manufactured in the same plant. Another query was: "Are all those prospective machines needed for military equipment?" The answer is that every effort will be made to place them in plants where the final result will be accomplishment of more war work in that particular plant.

While on this subject, it is pertinent to point out that if the Armed Forces want flash-lights, razor boxes, etc., and find that established molders are refusing to take the order, they will then insist that the machines be given to those molders who will produce the job.

Extruders for plastics are even tighter than injection machines. The reason is that it takes as much as 26 weeks to make some of the machines, and every available extruder is snapped up by the Army, Navy or rubber industry as soon as it becomes available. The number of machines needed by the Armed Forces for wire coating alone seems to mount by the week.

Compression presses have been going out quite liberally to old, established firms with at least 40 percent war business in their plants. There have been many requests from would-be newcomers in the plastics field for this type of equipment, but no evidence to indicate that they are getting presses ahead of already-established molders who have been restricted for months.

New facilities

It is hoped that WPB will soon get around to permitting additional construction of facilities in the chemicals and plastics industry. Just one example illustrates the case, and there are many similar ones. Polystyrene is today comparatively scarce although there is tremendous capacity for styrene monomer—most of which is going into rubber. However, when the day comes that more styrene can be diverted to the manufacture of polystryene, there will be no facilities to convert it unless action is taken soon. Experts say that it will take a year to build polystryene facilities, and it seems logical that WPB should give some encouragement to manufacturers that would permit them to develop definite plans for beginning construction of facilities to be used in the manufacture of polystyrene. These, of course, would be big projects, but there are scores of examples where small operators would welcome the opportunity to improve or increase their floor space.

Who will replace industry men in government

An insight into the troublesome time confronting industry and Government was forcibly impressed upon this writer a few days ago when an Army officer said: "Can't you do something to impress your readers with the thought that the war is still going on?"

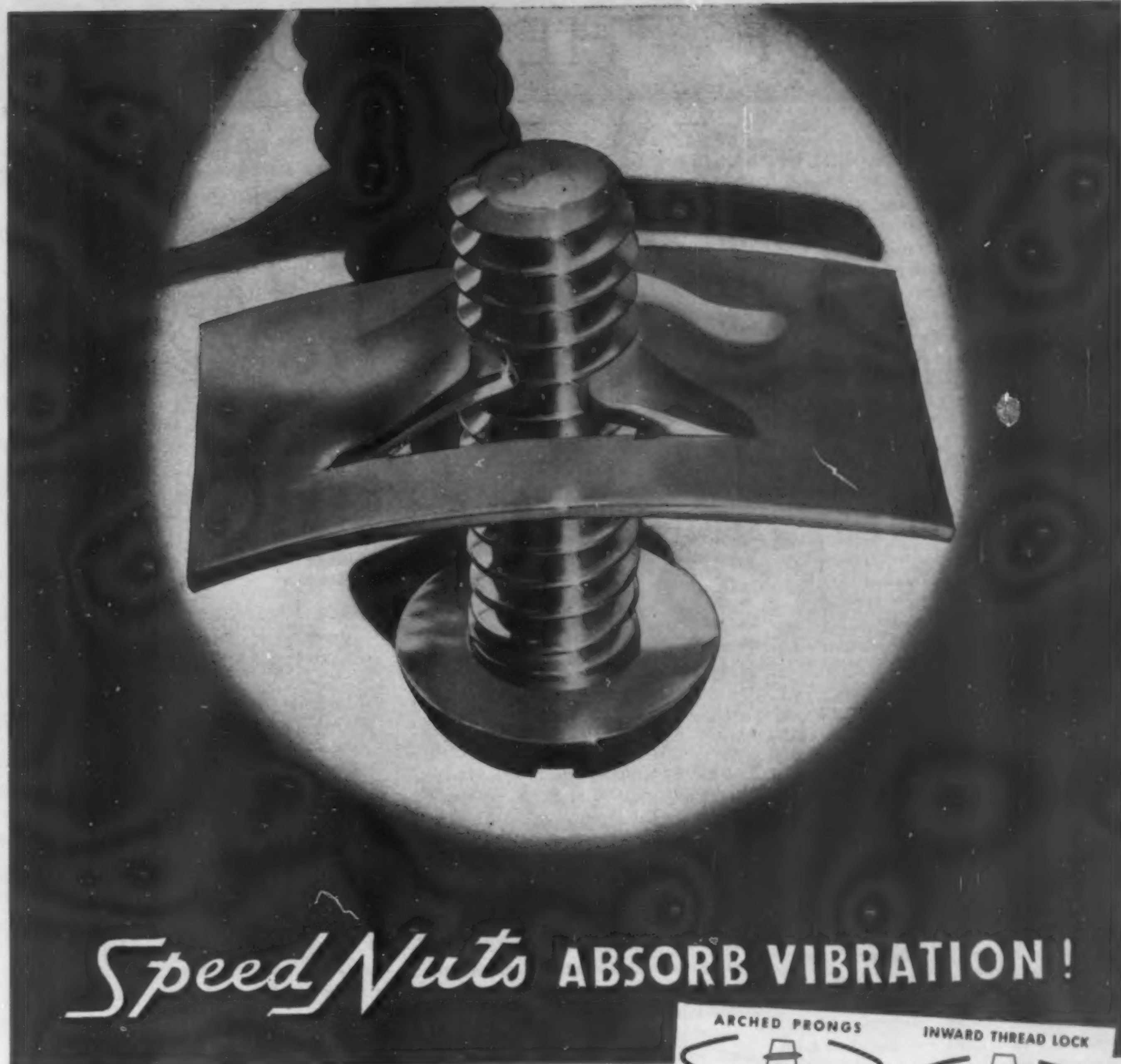
The irony of the statement is that it was made in a Government office in the presence of a dozen or more WPB officials, nearly all of whom are planning—hoping—to get back into private industry just as soon as Germany topples—or sooner, if possible. No one can honestly blame them for that. They have rendered loyal and efficient service to their Government and their industry. Most of them have spent a long time in this Washington welter, and they are entitled to relief.

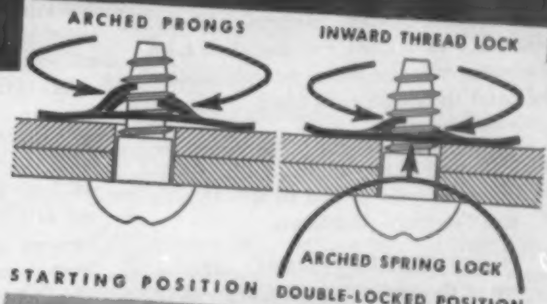
But their prospective departure creates another serious situation. The business of producing for war must go on until all the enemy are completely smashed. The period between the fall of Germany and the collapse of Japan may be considerably extended, and the problems of partial reconversion, deciding who gets what and who does what, are not picayunish. There may even be a chaotic period after the fall of Japan when experienced hands will be sorely needed.

Far-seeing industry leaders must be aware of the dangers involved if presently well-manned Government posts are filled with inexperienced—perhaps anti-business—personalities. No one has come forward with a solution, but the general welfare will most certainly suffer if industry men leave Washington in a body and nothing is done to replace them.

Urea order modified

On July 7, WPB announced the transfer of the urea and melamine order, M-331, to a section of the General Chemicals Order M-300. Urea and melamine molding powder is now governed by Schedule 35 of M-300, and all other urea and melamine resins are governed by Schedule 34 of M-300. *(Please turn to page 196)*





The base and the prongs of the Speed Nut remain well arched and there's no installation torque as the screw quickly turns into the Speed Nut to starting position.

As the screw is tightened, the arch of the base is reduced and the prongs are forced deeper into the root of the screw thread, to provide a double-locking action.

One of the deadliest enemies threatening the life of most products is VIBRATION. The only self-locking nut that conquers destructive vibration by ABSORBING it, is the SPEED NUT.

Made of LIVE spring steel, accurately heat treated, the SPEED NUT has two arched prongs that cushion and ABSORB the most severe vibration, to definitely prevent vibration loosening.

In addition, SPEED NUTS are extremely light in weight. They are quickly and easily applied. And they cost considerably less than other fasteners.

Small wonder, then, that millions of SPEED NUTS were used prior to the war, on automobiles, radios, stoves, refrigerators and thousands of other products . . . more are being used today on all types of military equipment . . . and more than ever before will be used after the war is won. A brief letter will bring you full details.

Speed Nuts* [PATENTED]

TINNERMAN PRODUCTS, INC.
2048 FULTON ROAD • CLEVELAND 13, OHIO

In Canada: Wallace Barnes Co., Ltd., Hamilton, Ont.
In England: Simmonds Aerocessories, Ltd., London

*Trademark Reg. U. S. Pat. Off.

NEWS OF THE INDUSTRY

★ LOUIS W. COLE, PRESIDENT OF Federal Electric Products Co., Newark, N. J., has announced his company's purchase of the Electrical Division of Colt's Patent Fire Arms Manufacturing Co., Hartford, N. J. The Colt group of service equipment and load centers, multi-breakers, motor starters and overhead relays has been added to the Federal line of products covering the field of safety switches, panelboards and circuit breakers. The Hartford plant will be under the supervision of Thomas M. Cole, executive vice-president of Federal.

★ AT THE 108TH MEETING OF THE American Chemical Society, to be held in New York City on September 11 to 15, scientists from laboratories of the chemical industry will report on research in plastics. This symposium is one of a series of events to be attended by 7000 representatives of the chemical, industrial and allied fields.

★ CASEIN COMPANY OF AMERICA, Div. Borden Co., New York City, announces the appointment of W. F. Leicester as its president. Mr. Leicester, who was formerly vice-president, succeeds William Callan, who will continue as a member of the board of directors.

★ W. C. HARDESTY CO., NEW YORK City, and Amecco Chemicals, Inc., Rochester, N. Y., have joined in the organization of the Hardesty Chemical Co. with offices at 41 E. 42nd Street, New York City. The new company will produce sebacic acid, capryl alcohol, dibutyl sebacate and related compounds. Both original companies will continue production and distribution in their respective fields as heretofore.

★ THE OFFICES OF PLASTIC CENter Co. have been moved to 809 Mission St., San Francisco, California.

★ THE INTERIM BOARD OF DIrectors of the newly formed Chemical Institute of Canada, Toronto, Ontario, in the course of its two meetings to date, has elected the following officers: L. E. Westman, chairman, Dr. P. E. Gagnon, honorary treasurer to the board, and Dr. R. R. McLaughlin, honorary secretary to the board. Dr. H. R. L. Streight was assigned portfolio as director of business, Dr. R. V. V. Nicholls as director of information, W. E. Pomeroy as director of conferences, Dr. L. Lortie as director of professional affairs, and L. E. Westman as director of external relations.

★ BAKELITE CORP. ANNOUNCES the appointment of Dr. Charles E. Staff and Ira S. Smith Sheffler, Jr., to its Research and Development Laboratories in Bloomfield, N. J. Dr. Staff will be in charge of the Molding Division.

J. HARRY DUBOIS

★ ANNOUNCEMENT HAS BEEN made of the appointment of J. Harry DuBois as executive engineer for the Shaw Insulator Co., Irvington, N. J. Mr. DuBois, author of the textbook "Plastics," was formerly commercial engineer for the Plastics Divs., General Electric Company.

★ H P. SCHRANK, VICE-PRESIdent of Seiberling Rubber Co., Akron, Ohio, has announced the addition of Dr. Raymond P. Allen to the company's development staff. Dr. Allen's assignment will be the study of improved cotton, rayon, nylon and other fibers for use in tire carcasses.

★ LESTER-PHOENIX, INC., CLEVEland, Ohio, has appointed Elmer C. Maywald of Chicago, plastics consultant, as the firm's representative in the Chicago territory, which includes northern Illinois, western Michigan, northern Indiana, Iowa, Minnesota and Wisconsin. Mr. Maywald will handle the firm's complete line of plastic molding and die casting machinery.

★ UNITED STATES RUBBER CO., New York City, has appointed Stanley W. MacKenzie as director of purchases to succeed George M. Tisdale, now vice-president and member of the executive committee of the company. Mr. MacKenzie joined the company in 1920.

★ ROBERT L. DAVIS, FORMERLY instructor in Plastic Engineering at Purdue University and Indiana sales engineer for General Electric Co., Plastics Divs., has resigned his position to join the sales staff of Plastics Div., Continental Can Co.

★ THE FALL CONFERENCE OF THE Society of the Plastics Industry will be held on Nov. 13 and 14 at the Waldorf-Astoria Hotel in New York City. C. S. Shoemaker of Dow Chemical Co. heads the meeting committee which is giving special emphasis this year to group meetings. Further details of the program will be announced as the various arrangements are completed.

★ EDWARD KATZINGER CO., Chicago, Ill., announces the change of its firm name to that of Ecko Products Co., to coincide with its trade-mark.

★ CHARLES A. POWEL, MANAGER, Headquarters Engineering, Westinghouse Electric and Mfg. Co., Pittsburgh, Pa., has been elected president of the American Institute of Electrical Engineers. Mr. Powel, formerly vice-president and director of the AIEE, will succeed Dr. Nevin E. Funk, vice-president, Philadelphia Electric Co.

★ H. MUEHLSTEIN & CO., INC., New York City, dealers in rubber and in plastic and rubber scrap, announces the election of William J. McCauley as president. He succeeds Herman Muehlstein, who now becomes chairman of the board of directors.

★ SAMUEL LEVY HAS BEEN elected president and managing director of the newly organized Greentree Products, Inc., 1140 Broadway, New York City, a firm engaged solely in the promotion and distribution of plastics fabrics and products. The company will foster the development of plastic sheeting for closet accessories, shower curtains, bowl covers, food bags, rain wear, table cloths and other items for notion and housewares departments. Mr. Levy was formerly manager of the plastics division of the Arnel Co., Inc., New York City.

Due to the paper shortage, an index to Volume 21 of *Modern Plastics* (Sept. 1943–Aug. 1944) is not included in this issue. However, a limited number of indexes have been printed and are available to subscribers who request them from the Readers' Service Dept.

Why Plastic Plans Start with Polystyrene

Its outstanding properties . . . its huge production and consequent availability in the future . . . its low price . . . all these factors point to Styron (Dow Polystyrene).

To say that plastic plans start with Styron (Dow Polystyrene) is to make a big statement. But analysis of the plastics field shows it to be backed up by many factors—factors of far-reaching significance.

The things that Styron is capable of doing—its wide field of application—plus the production capacity and resultant economic advantages create a distinct niche for Styron in the plastics field.

Let's look at availability, for example. To meet huge war needs, Styron manufacturing facilities were expanded tremendously and production zoomed upward. These extensive facilities—the greatest of any plastic material—mean that the future price tag on Styron will be right—perhaps even revolutionary.

As to the material itself, the properties of Styron are already well known. Its many uses have been proved again and again . . . for electrical applications where outstanding insulating properties are required . . . in the field of science where immunity to acids and alkalies is important . . . for precision moldings that must retain their shape and detail . . . for jewelry and decoration where brilliant color and clear transparency are demanded.

You will want to know more about Styron—it is the plastic to keep your eye on. We'll be glad to send further details.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago
St. Louis • Houston • San Francisco • Los Angeles • Seattle

DOW PLASTICS INCLUDE

- **STYRON . . for fabricators producing moldings, extrusions, rod, sheet.**
- **ETHOCEL . . for fabricators producing moldings, extrusions, coatings; available also as Ethocel Sheeting.**
- **SARAN . . . for fabricators producing moldings, extrusions, pipe, tubing, sheet; available also as Saran Film.**

STYRON

(DOW POLYSTYRENE)

DOW

CHEMICALS PLASTICS MAGNESIUM

INDISPENSABLE TO INDUSTRY AND VICTORY

Structural materials

(Continued from page 139)

Properties of pulp-core paper-face composites

In considering the physical properties of any sandwich material, the characteristics of the surface material under the various molding and fabricating conditions encountered are of prime importance. Variations in the pressure applied to the surfaces depend upon the method of applying the surface sheets to the composite plastic. If the core material is formed and cured before assembling the sandwich, molding pressures in the range 100 to 200 p.s.i. may be employed. But if the core and surfaces are assembled before molding, relatively low pressures must suffice if low density is to be maintained. In this latter case, the actual pressure exerted upon the surfaces during molding will depend only upon the resistance to compression demonstrated by the core. The type of fibers present, the final core density and its thickness are principal factors responsible for this back-pressure.

The variation of some physical properties of a typical high-strength laminated paper (containing 35 percent phenolic resin) with the molding pressure is shown in Fig. 17. If these data are replotted in terms of specific properties (Fig. 17), it can readily be seen that the molding pressure, within certain limits, can play only a minor role (less than 10 percent) in fixing the physical properties of a sandwich material. In effect, the number of sheets of paper in each surface is the only significant variable in determining the load-bearing capacity of the surfaces. This statement has been verified by tests on a very large number of sandwich specimens having high-strength laminated paper (phenolic resin) surfaces. Similar results have been found for sandwich boards having cotton and Fiberglas fabric surfaces.

To illustrate some basic physical properties of sandwich boards of various compositions, a limited amount of test data

17

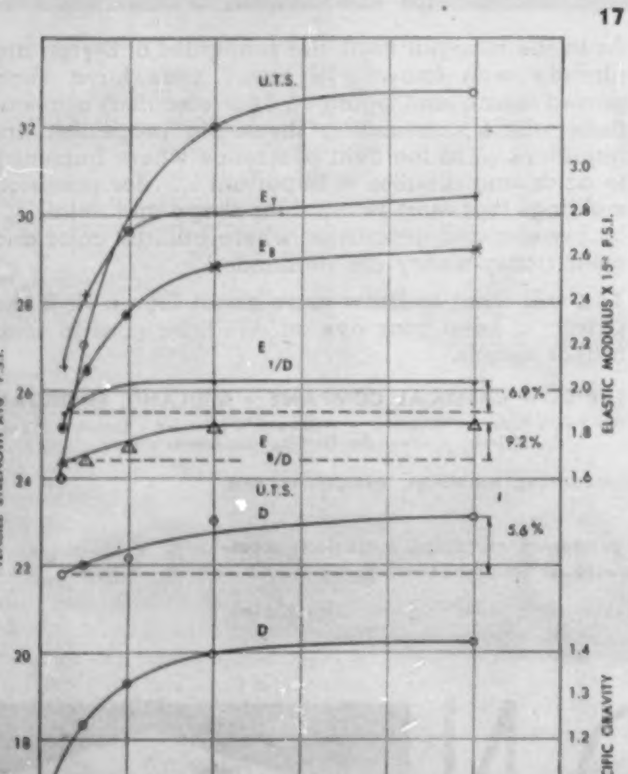


Table IV.—Properties of Some Composite Plastics

Sample	Core weight	Specific gravity	Bending modulus, $\times 10^{-6}$	Bending modulus, sp. gr.	$\frac{E}{D^3} \times 10^{-6}$
	percent		*p.s.i.*	*p.s.i.*	*p.s.i.*
Cotton duck faces; fiber-resin core	55.5	0.704	0.60	0.854	1.72
Cotton duck faces; fiber-resin core	51.0	0.732	0.65	0.887	1.65
Cotton duck faces; fiber-resin core	45.5	0.685	0.60	0.875	1.89
Fiberglas fabric faces; fiber-resin core	54.0	0.705	1.61	2.28	4.59
Fiberglas fabric faces; fiber-resin core	53.0	0.63	1.41	2.24	5.64

is recorded in Table III. For comparison purposes, values are included for 24ST aluminum alloy, mahogany plywood and a high-strength paper laminate. The sandwich specimens discussed show no "grain effect," hence single values are reported. All sandwich specimens were prepared by bonding high-strength paper to pre-cured fiber-resin cores. Molding pressure was 100 p.s.i. in all cases.

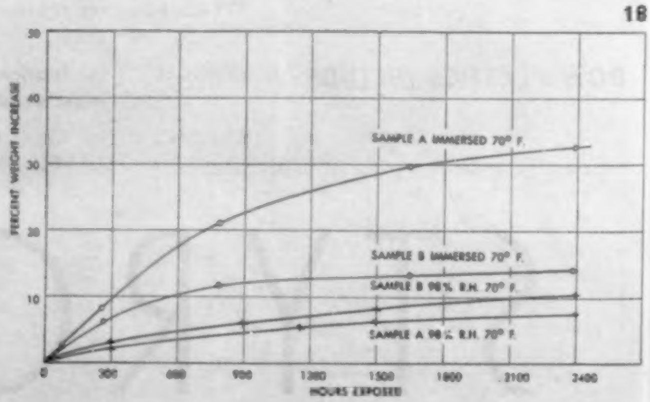
In Table IV comparative bonding data are recorded for sandwich panels having resin impregnated 12-oz. cotton duck and Fiberglas fabric (ECC-127) surfaces and fiber-resin cores. Cotton duck surfaces contained 50 percent phenolic resin and the Fiberglas surfaces 35 percent phenolic resin. Surfaces were cross-laminated in these specimens and molding was carried out at 300° F. and 100 p.s.i.

Waterproofing of low-density materials

The utility of a structural material is very frequently limited by its moisture absorption. This is particularly true in aircraft material where any appreciable weight increase cannot be tolerated. In most cases dimensional changes and decrease in physical properties, which usually accompany absorption of water, are even more serious disadvantages than is weight increase. A considerable number of otherwise satisfactory plastic materials have been excluded from many aircraft applications because of the adverse effects of absorption of water. This has proved particularly true with many laminated units which have variable thicknesses of section; differential rates of water absorption in the

17—*This chart shows the physical properties vs. molding pressure.* 18—*A comparison of water absorption of two laminates under immersion and high humidity conditions*

18



NOW-MOLD THICK SECTIONS WITH ELECTRONIC PREHEATING

"Size of moldings and thickness of section no longer present any limitations," say Bakelite engineers

ELECTRONIC preheating quickly produces uniform plasticity throughout the preform regardless of thickness or size. Such preforms are easy to mold.

By raising the preform almost to curing temperature before molding, *curing* temperature can be quickly reached in the mold. Curing can then be completed uniformly and rapidly.

Bakelite Tests: The tests shown by the following table was reported by Messrs. V. E. Meharg and A. P. Mazzucchelli of Bakelite Research and Development Laboratories in June, 1944, "Modern Plastics Magazine." Note the improved properties when electronic preheating is used.

PROPERTIES OF THICK BLOCKS (6 by 6 by 2¾ inches) AND STANDARD SPECIMENS MACHINED THEREFROM

A range of values as shown indicating results from various parts of the block.

Material: Woodflour-filled phenolic

PROPERTY	Standard Molded Cure: 2½ hours Discharged cold Pressure: 2100 p.s.i.	Electronic Preheated Cure: 5 minutes Discharged hot Pressure: 2100 p.s.i.
Overall density	1.335	1.329
Swelling (on discharge)	+0.62%	+0.99%
Acetone extractives (A.S.T.M.)	1.49%	1.39%
Average tensile, p.s.i.	4200±988	5440±548
Average deviation in tensile	±23%	±10%
Elongation	0.416±0.087	0.581±0.066
Average deviation in elongation	±21%	±11.4%
*Average impact, ft.-lb. energy to break	0.160±0.012	0.171±0.014
Average deviation in impact	±7.5%	±8.2%

*Special machined specimens.

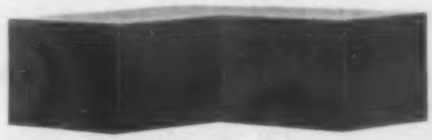
The authors summed up principal advantages of electronic preheating of thermosetting materials, as follows:

"a) Faster rate of cure and hence *higher production*.
b) Reduced pressure necessary for molding, or
c) Greatly improved flow at normal pressures."

On the average, electronic preheating enables two presses to do the work of three!

Equipment Available: RCA can provide electronic generators for priority orders. The new RCA model 2-B, *especially designed for the Plastics Industry,* will preheat one pound of molding material to 275°F. in 40 seconds under average conditions . . . operates as simply as a toaster. Send the coupon, or write for further information (please state your problem), to RCA, Electronic Apparatus Section, Box 70-102, Camden, N. J.

STANDARD-MOLDED block 6 by 6 by 2¼ inches, cured 1 hour at 320°F, 2100 p.s.i., discharged hot.



ELECTRONICALLY PREHEATED block 6 by 6 by 2 inches, cured 5 minutes at 320°F., 2100 p.s.i., discharged hot. (Same material in both blocks.) Note time saved in molding heavy sections. Photographs Courtesy of Modern Plastics Magazine and Bakelite Corporation.

LEFT: The RCA 2-kw electronic generator especially designed for the Plastics Industry. (Send coupon for bulletin.)
RIGHT: The RCA 15-kw electronic generator for larger jobs. Will heat 7½ pounds to 275°F. in one minute.

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various sections were responsible for the development of serious warpage and distortion.

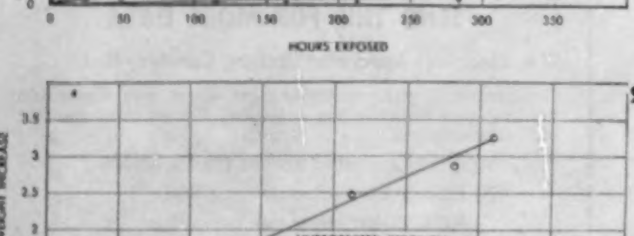
All porous materials are, of course, inherently capable of taking up large amounts of water even when they contain no hygroscopic constituents. An ideal porous material would possess a closed cell structure and all of its components would be non-hygroscopic. However, even the so-called closed cell expanded materials contain some regions of a capillary nature and will take up a surprisingly large amount of liquid water.

In sandwich construction, face materials as well as cores very frequently need to be protected. This is particularly true in the case of plastic laminates which contain cellulosic reinforcements. Both paper and fabric laminates, when formulated under conditions which are most favorable for the development of high mechanical properties, show high moisture absorption in long-term tests under immersion or high humidity conditions and suffer marked decreases in all physical properties as a result of absorbed water.

For complete protection of the sandwich construction, if the face material absorbs or transmits moisture, some type of surface protection is required. This action is necessary in addition to the general need for protecting the edge of the sandwich in order to prevent penetration of moisture into the porous core. Whether a plastic material is to be used under high humidity conditions or subjected to direct action of water, its moisture resistance is commonly tested under immersion conditions—an erroneous procedure as can be seen by Fig. 18 which shows that one material may be superior to another in moisture resistance under immersion testing but inferior when tested in high humidities. In order to avoid incorrect conclusions concerning the moisture absorption of materials and concerning the effectiveness of various protective methods, it is necessary to know the conditions under which the material must perform. And all testing must be conducted under conditions which approximate those which will be encountered in service.

19—Immersion tests on protected and unprotected sandwich specimens, 70°. 20—Ninety-two percent relative humidity exposure of protected and unprotected specimens

19



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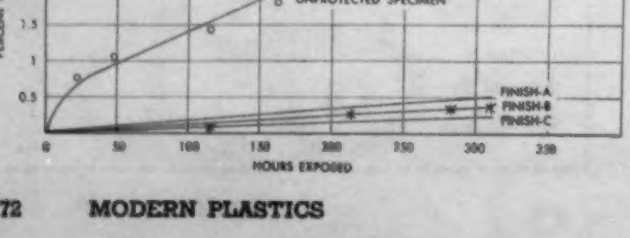


The degree of protection afforded by several protective coating systems which were formulated especially for the protection of plastic materials against moisture uptake was determined. The sandwich panels employed in these tests were all identical and had the following characteristics:

Specific gravity = 0.65

$$\frac{\text{Core thickness}}{\text{Total thickness}} = 0.80$$

High-strength paper faces; 35 percent phenolic resin.
Fiber-resin cores; 50 percent phenolic resin.

The edges of the panels were sealed with wax, and protective finishes, containing 34 percent aluminum (solids basis), were applied in three coats and baked at suitable temperatures after each coat. The coating weight in each case was 14 grams per square foot. Finishes A and C were vinyl formulations and Finish B, an oil-modified phenolic material. The effectiveness of these finishes is apparent from Figs. 19 and 20.

Solvent immunization

(Continued from page 140) treated surface is unaffected by a 72-hr. exposure at high temperature and high humidity (100° F. and 100 percent relative humidity), and a 200-hr. exposure in an accelerated weathering test (A.S.T.M. D 795–44T) does not change the treated surface of a weather-resistant formula. A difference in surface appearance is obtained depending on the presence of water in the hydrolyzing medium. There is a tendency for the alcoholic potassium hydroxide to make the surface brighter after hydrolysis than that of an untreated sample. On the other hand, the alcohol-water mixture makes the surface duller than that of the blank. If acetone is substituted for ethanol in the 25–75 ethanol-water mixture, an even duller surface is obtained.

The concentration of the caustic in the treating solution diminishes very slowly over an extended period of dipping. More rapid change is due to the evaporation of the softening agent from the solution. Accordingly, adjustments should be made from time to time to bring the solution to the desired concentration.

The surface hydrolysis action is apparently independent of the plasticizer used in the plastic, and the physical properties of the plastics are apparently unchanged by the treatment. Tests for flow temperature, elongation, tensile strength, weight gain on immersion in water, and leaching were run on dipped and undipped samples. For these tests the specimens were cut from compression-molded sheets of cellulose acetate butyrate plastic. The standard Izod impact test would not work in this instance as the solvent treatment affected the notch. To check this point, six gas mask valve guards molded from cellulose acetate butyrate plastic were tested by the falling-ball method. The test pieces were dipped for 3 min. in a 3 percent potassium hydroxide solution in ethanol, rinsed thoroughly and dried in a 150° F. oven. They were conditioned at 77° F. and 50 percent relative humidity before testing. There was no difference between untreated and treated lots, indicating the properties of plastic were unimpaired.

To determine how effective a solvent protection this hydrolyzing treatment provides, samples of cellulose acetate and cellulose acetate butyrate plastics have been immersed in a wide variety of solvents and solvent plasticizers. Results for 1-min. immersion tests have been summarized in Table I. These short-time immersions demonstrate quite clearly the type of protection against active solvents which is given by

surface hydrolysis. Of the 18 solvents tested, none will appreciably harm the surface of the treated cellulose ester plastics in a 1-min. immersion. The ethanol and ethanol-water mixtures have a very slight softening effect which is not noticeable after redrying of the dipped sample. This form of solvent resistance makes entirely possible cleansing operations, heretofore not considered practical, on articles molded from cellulose ester plastics.

Surface hydrolysis does not give immunization against long-time exposure. Results for 16 and 36 hr. immersion tests have been summarized in Table II. These longer tests are the basis for the following general conclusions: Surface hydrolysis provides good protection against long-time exposure of both cellulose ester plastics in solvent types of plasticizers such as triacetin or dimethyl phthalate. It is not effective for continued exposure to very active solvents such as acetone or the Cellosolves. Treated cellulose acetate butyrate seems more resistant than treated cellulose acetate against the ester solvents such as methyl Cellosolve acetate and against the ether alcohols such as Carbitol. Both treated cellulose ester plastics are swelled and softened by ethanol and methanol. Methanol has an especially bad effect on cellulose acetate butyrate. Various ethanol-water mixtures affect the treated samples as much as the blanks. This is not unexpected as it has been shown that cellulose esters which are sufficiently hydrolyzed to form the diester are dissolved or partly dissolved by ethanol-water mixtures.

Surface hydrolysis gives good protection to both cellulose esters against oil of pennyroyal, oil of lavender and oil of wintergreen. Both blanks and treated samples are unaffected by oil of eucalyptus, oil of citronella and oil of lemon. Generally, these results indicate that a more effective surface hydrolysis is obtained by using sodium hydroxide in ethanol-water instead of potassium hydroxide in ethanol.

Summary

This paper describes a surface hydrolysis process for molded cellulose ester plastics which provides limited protection against certain active solvents and long-time exposure protection against several solvent plasticizers and natural oils. The discussion presented in this paper is made as a technical service for the users of cellulose ester plastics. No mention is made of patents which may be applicable to the methods, formulas and materials given in the foregoing article. The statements should not be considered as recommendations for the use of any of these methods in violation of any patents now in force or which may be issued in the future.

Sheep in mink's clothing

(*Continued from page 109*) machine during which the temperature of the wool is held between 70 and 110° C. This heat treatment completes the formation of the condensation products. The remaining operations consist of the clipping off of uneven fibers and finishing or polishing on a cylinder rotating at the rate of 900 revolutions a minute. Here the hairs are alternately sucked in and pushed out so that each hair is individually finished.

The resultant fur is soft and silky to the touch with the thick rich body that one associates with luxury furs. The product is then dyed to conform with the true tones of the fur which it is simulating. In the case of the lambswool turned lynx, the fur is a lovely off-white with a darker center.

In the treatment of fabrics, another phase of the process is illustrated—the encasement of the fibers by a thermosetting plastic without modification of the chemical nature of the parent substance of the fiber. Since filaments of a cellulosic nature require different types of reagents capable of combining primarily with the hydroxyl groups present in cellulose, the reagents used are carefully modified to suit the particular need—whether it be the addition of body or silkiness or the imparting of crease resistance. However, similar chemical reactions to those that take place in the treatment of sheepskins and furs are carried out.

An application of particular merit is the stiffening of brush bristles. Formerly, great quantities of the bristles were labeled inferior because they did not possess sufficient rigidity to meet high-quality specifications. By subjecting the bristles to the action of the formaldehyde and baking them in an autoclave operating under a developed pressure of from 20 to 75 p.s.i. for from 30 to 90 min., the keratin of which they are formed is rendered less susceptible to chemical reaction, resulting in a tough, stiff bristle equal to the most rigid tests for this type of material.

Perhaps the most interesting aspect of the invention from the consumer point of view, is the experiments conducted on felt, pile and carpeting. For over a century there has been no basic change in the carpeting field. Therefore, to learn that this process can effect on these materials the same properties it imparts to animal pelts—moth-, water-, wear-resistance and luster—stirs the interest of all who have watched priceless rugs serve as banquets for moths, mat into unwieldy lumps or become threadbare long before their normal span of years was reached. Substantially the same process as is applied to furs and materials is followed here, with due allowance for the requirements of handling imposed by basic differences in composition and results desired.

The possibilities of application to other industries latent in this method are manifold. Many new developments are in process at the laboratories. Others have been successfully produced on a pilot plant scale in the test plant of Calva Laboratories. Others are still in the embryo stage. The criterion for their present development is their immediate usefulness to the war program. With the coming of the peace we can expect to find many products bearing the label of this process on the market.

Checking the angles

(*Continued from page 107*) in the new protractor are aged before the metal edges are screwed and doweled in. Following assembly into the finished product, the edges are again ground and finished. As completed for the Air Force at this time, the protractors have attractive individual wooden cases and two types of finishes—glossy and instrument (dull).

During the two years of experimental work on a plastic protractor, a number of different plastics were tried. It was found that high acetyl acetate stood up most satisfactorily under the required temperature cycle of −58 to +158° F., and this is the material now used in all the protractors.

A number of tests in the plant of the molder showed the ability of the new instrument to hold up under strenuous conditions of usage. However, one of the most effective trials of this nature was strictly impromptu. An Army mechanic, using the instrument in a large plane hangar, dropped it 60 feet. Although the glass in the levels was broken and the squareness of the edges impaired, none of the parts were jammed. The protractor was still workable, and there was little interference with accuracy.

In addition to the Army Air Force, the Navy and several

aircraft manufacturers have placed sizeable orders for the plastic protractors. Since the device affords an easy, quick way to check many different types of angles, numerous post-war uses are envisioned—even to its use by carpenters. However, costs which are necessarily high may limit the instrument's future application.

Credits—Material: Lumarith X. Molded by Cruver Mfg. Co. for Army Air Force and Navy

Effect of prolonged heating

(Continued from page 142) for testing similar to that recommended by the U. S. Forest Products Laboratory for testing glue joints. The Izod impact specimens were tested in a 8 to 16 ft.-lb. capacity impact machine (Fig. 7). The Izod specimen was of the usual notched type and is described in Federal Specification L-P-406 a, Method No. 1071.

Moisture absorptions and dimensional stability data were obtained from individual specimens 1/2 by 1/2 by 6 in. (6 in. dimension across the grain and parallel to the lamination). These specimens were immersed in water for 48 hr. at room temperature. The moisture pick-up was calculated by weighing the specimen when dry and again after immersion, and expressing the difference as a percentage of the original dry weight. The dimensional stability of the same specimen was determined by measuring the swelling of the laminations in the direction of compression (radial in terms of wood structure) with a micrometer. Measurement was made before and after immersion in water at a point approximately in the center of the test piece. This point was marked on the dry specimen so that reference could be made to it after immersion. Specific gravity determinations were made by weighing the specimen dry and when submerged in water.

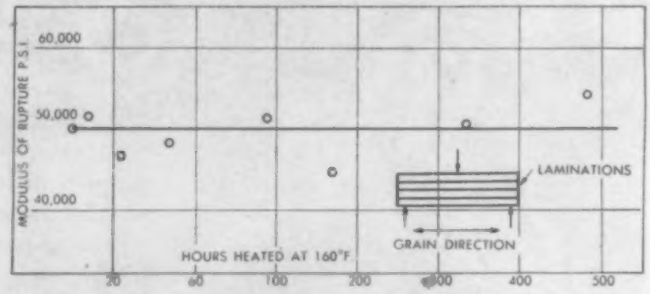
All specimens were cut with a circular saw from two compreg panels 1 1/2 by 12 by 36 inch. No further machining of the specimens was required prior to test except in the case of the Izod specimens, which were notched on a metal planer, and the moisture-absorption and dimensional-stability specimens, which were hand sanded before immersion. When the test specimens were cut out, each piece was numbered to

3—*Effect of heat on compreg—modulus of rupture.* 4—*Chart showing the effect of heat on compreg, with the shear parallel to grain and perpendicular to lamination.* 5—*Here the effect of heat on compreg is shown when the shear is parallel to grain and parallel to lamination*

Table I.—Dimensions of Test Specimens

Property	*Dimensions of specimens*
	in.
Modulus of rupture	1/2 × 1/2 × 7
Izod impact strength	1/2 × 1/2 × 2 1/2
Shear strength parallel to the grain and laminations	2 × 3 × 1 1/2, with 2 × 2 shearing surface
Shear strength parallel to the grain and perpendicular to the laminations	1/2 × 1/2 × 2 1/2
Moisture absorption and dimensional stability	1/2 × 1/2 × 6
Specific gravity	1 × 1.4 × 2.5

3



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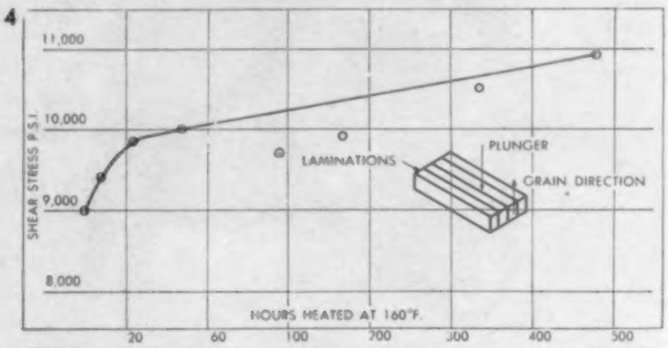

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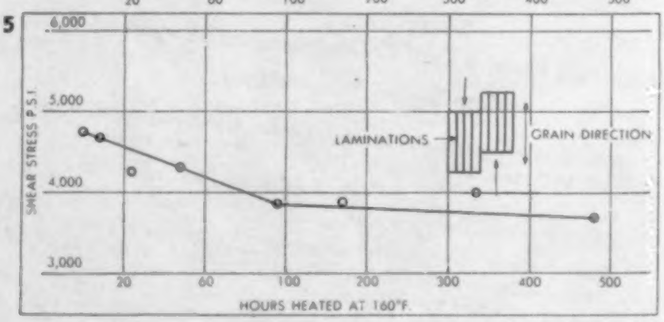

Table II.—Properties of Compreg Heated at 160° F. for Various Periods of Time[a]

Heating time	*Weight (1)*	*Specific gravity (1)*	*Moisture absorption (4)*	*Dimensional stability; swelling in water (4)*	*Modulus of rupture (5)*	*Shear ∥ grain and laminations (5)*	*Shear ∥ grain and ⊥ laminations (5)*	*Izod impact strength (5)*
hr.	*g.*		*percent*	*percent*	*p.s.i.*	*p.s.i.*	*p.s.i.*	*ft.-lb./in of notch*
0	493.68	1.28	2.82	1.80	50,300	9030	4740	6.55
8	490.62	1.27	2.91	1.94	51,800	9430	4680	6.32
24	490.07	1.27	3.13	2.32	46,600	9850	4220	6.61
48	489.07	1.27	2.88	1.76	48,200	9980	4290	6.48
96	487.94	1.27	2.94	1.78	51,200	9710	3850	6.64
168	487.00	1.27	3.11	2.16	44,700	9910	3870	6.47
336	485.92	1.27	3.02	1.95	50,500	10,500	4000	6.50
480	484.83	1.27	3.19	2.10	54,300	10,900	3680	6.79

[a] Figures in parentheses represent number of tests made. All tests were made after the specimens had been cooled to room temperature in a desiccator for at least 24 hours.

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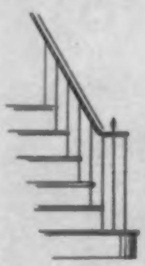

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indicate its position in the original panel. In making up specimen groups for the various heating intervals, the selection was such that the material in each group was representative of the entire panel. In this way, variations in the physical properties within the panel itself were averaged.

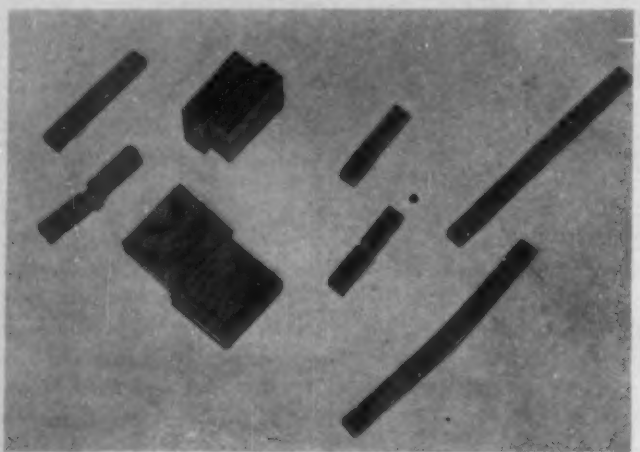
At the end of each heating interval, five specimens were removed for each of the following properties—modulus of rupture, Izod impact, shear parallel to the grain and laminations, shear parallel to the grain and perpendicular to the laminations. Four specimens were removed for moisture absorption and dimensional stability, and one for specific gravity. To obtain data for the original material, a like number of non-heated specimens were tested. These controls were not tested all at once but were spread out.

Discussion of results

Complete test results are recorded in Table II. Figures 3, 4 and 5 show the effect of heating at 160° F. on modulus of rupture and shear strength of compreg. A definite trend was noticed in the shear strength parallel to the grain and laminations. The ultimate shear strength in this direction decreased 25 percent in 96 hr. of heating after which the material appeared to stabilize at that level (Fig. 5). However, the shear strength parallel to the grain and perpendicular to the laminations tended to increase with prolonged heating—after 480 hr. of heating the increase in strength was approximately 20 percent (Fig. 4).

The results of the impact test show that this property is not greatly affected by prolonged heating at 160° F. The average value of the control specimens was 6.55 ft.-lb./in. of notch as compared to the average value of all heated specimens of 6.54 ft.-lb./in. of notch. No significant trends or changes were observed for modulus of rupture (Fig. 3), dimensional stability or moisture absorption. In these three properties, the compreg changed little or not at all after heating for 480 hours. It is interesting to note that although there was little change in the specific gravity (from 1.28 to 1.27) the compreg lost weight continually over the period of heating. It follows, therefore, that shrinkage also must have occurred continually and that this shrinkage must have been proportional to the loss in weight.

6—Specimens of the material before and after testing. 7—Instrument used in applying the Izod impact test



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7

Molding via grease gun

(Continued from page 100) vinyl paste. He could make insulating wire junctions or connections, or water-proof electrical parts by placing wire in the paste or by rubbing the paste on the wire with his fingers. The wire may then be placed in sockets or connectors and heated with a blow torch or alcohol lamp. The connection would then be sealed with an in-place molding. At present, this job is done with friction tape or rubber nipples. For other jobs, it might only be necessary to make a simple brass or metal mold on a turning lathe, fill the mold with paste, heat and cool. A practical application for automobiles in England has been the formation of a holding fixture at the base of the radio antenna rod which makes rod and holder one integral piece.

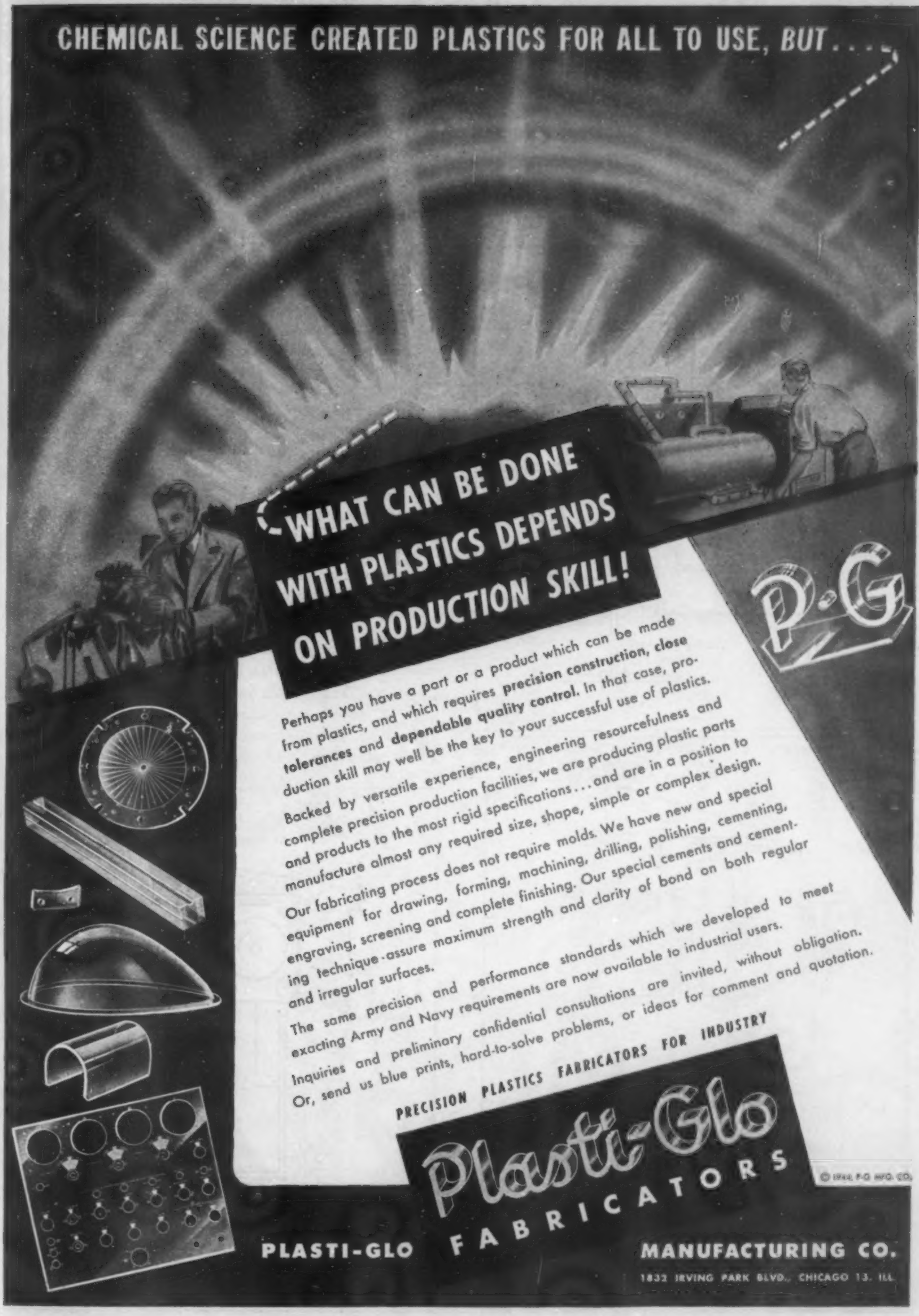
Apparently no material other than polyvinyl chloride has been used in the dispersion method. Some authorities suggest that it might be successfully tried with copolymers of polyvinyl acetate, polyvinyl butyral, and possibly with cellulose acetate and cellulose acetate butyrate.

Compression equipment

(Continued from page 123) be closed even by pressing the push button until such time as the temperature pen reaches the upper index.

When the temperature pen reaches the upper index the No. 2 pressuretrol is energized. The signal light indicates the press is at temperature. By pressing the momentary contact push-button the circuit is completed through the timer to relay No. 2 which energizes the normally closed 3-way solenoid No. 2, thereby closing the press. The press remains closed until the timing cycle is completed. When this cycle is complete, the relay No. 2 circuit remains completed, thereby keeping the press closed. Relay No. 1, however, de-energizes the 3-way solenoid No. 1. This action closes the steam line, and opens the cold water line and solenoid No. 3 in the bypass trap.

When the press temperature drops to the lower index, relay No. 2 through No. 1 pressuretrol drops out. This de-ener-


CHEMICAL SCIENCE CREATED PLASTICS FOR ALL TO USE, BUT....
WHAT CAN BE DONE WITH PLASTICS DEPENDS ON PRODUCTION SKILL!
P-G
Perhaps you have a part or a product which can be made from plastics, and which requires precision construction, close tolerances and dependable quality control. In that case, production skill may well be the key to your successful use of plastics.
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gizes solenoid No. 2, and the press opens automatically, the cold water is shut off and the steam turned into the press. Trap solenoid No. 3 remains open until a predetermined setting of the temperature controller is reached at which time the trap solenoid closes. This action allows the incoming steam to blow all lines and die channels clear of trapped cooling water prior to the time the trap closes. The cycle is then repeated.

System No. 2—This system is basically the same as that of No. 1. However, this method also automatically controls the press at its molding temperature by regulating the steam flow to the platen by means of a diaphragm-operated valve in the steam line. The only change is that the direct-acting control system becomes a throttler-type rather than an "on-off" control. The steam throttling valve would be positioned in the system behind the 3-way air operated steam and cold water valve. Figure 2 is a schematic layout of this arrangement.

System No. 3—This system differs from that of No. 1 and 2 insofar as it incorporates an electronic potentiometer which uses a small gage thermocouple instead of a thermometer bulb, has a greater degree of accuracy, a faster speed of response and greater sensitivity (see Fig. 3). The auxiliary switch actuates the relay coils instead of the No. 1 pressuretrol.

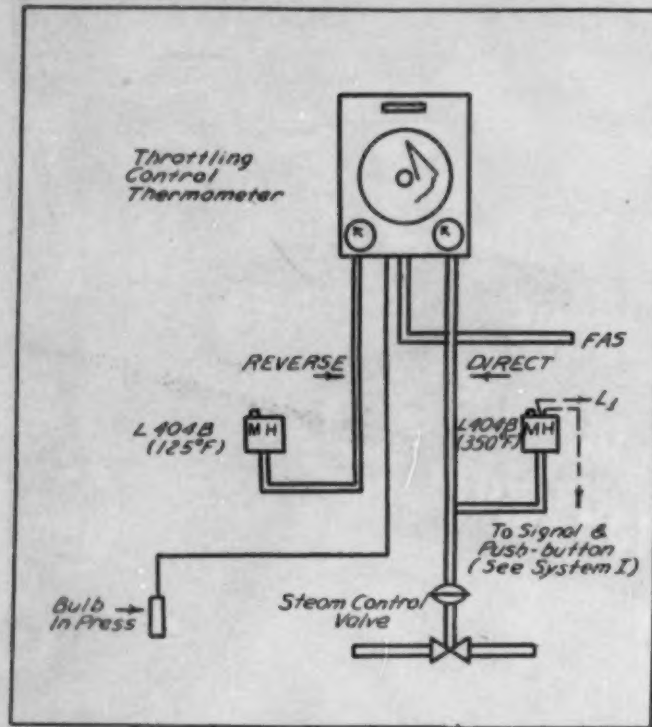
System No. 4—This system (Fig. 4) is basically the same as No. 3 except that it controls the press temperature by means of throttling a steam air-operated valve, as does System No. 2, but utilizes a throttling-control electronic potentiometer.

Thus we have four interlocking control systems which:

1. Prevent an operator from closing a press that is below temperature.
2. Guarantee correct curing temperatures.
3. Automatically close off the steam inlet, open a trap by-pass and open a cooling-water inlet.
4. Cool molded pieces to a *predetermined temperature*, thereby insuring constant temperature of ejected pieces regardless of fluctuations in the temperature of incoming cooling water.
5. Automatically open the press when pieces are cooled to the correct temperature, close off the incoming cooling

DRAWINGS, COURTESY BROWN INSTRUMENT CO.

2



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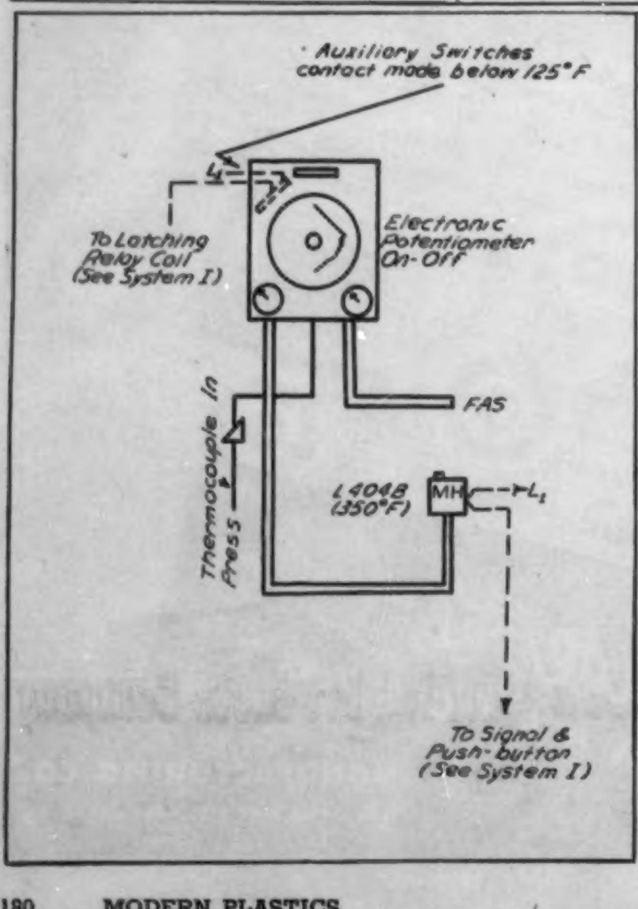
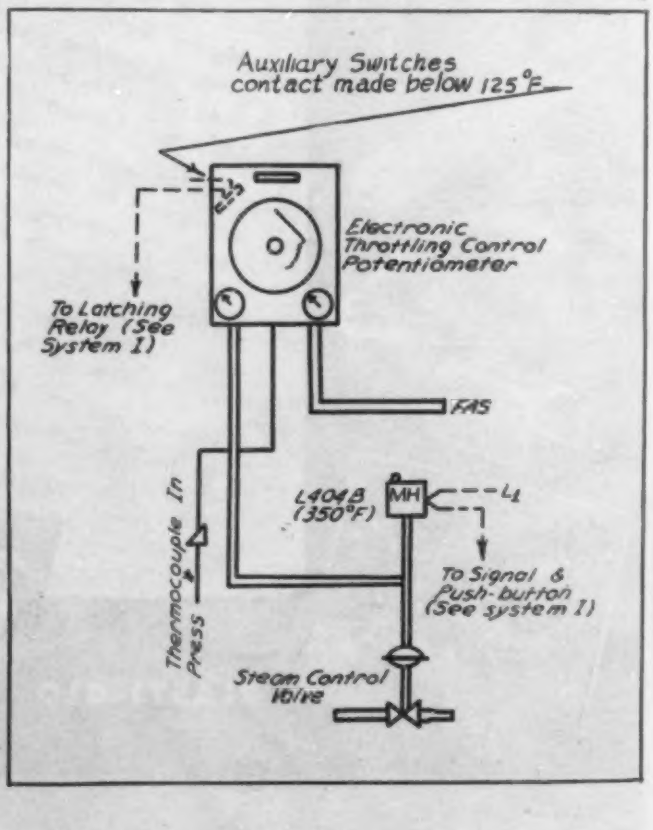


2—Schematic layout for System No. 2. 3—The arrangement for the No. 3 system differs from those of Nos. 1 and 2 in that it incorporates an electronic potentiometer which uses a small gage thermocouple. 4—System No. 4 utilizes a throttling control electronic potentiometer but is otherwise basically the same as System No. 3

4



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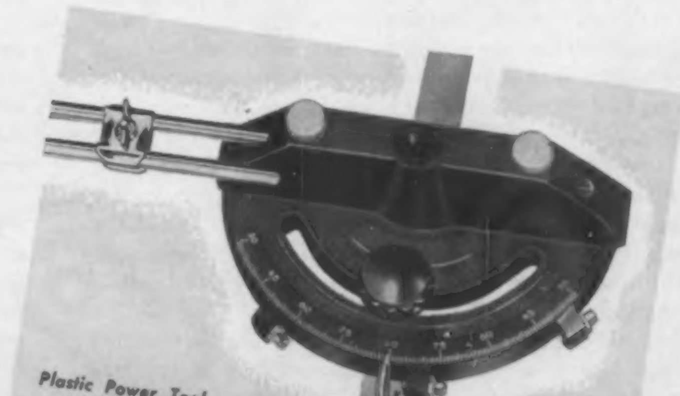

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water line, open the incoming steam line, blow all trapped water out, and close off the trap by-pass.

6. Provide a record of press cycles completed by showing the number of curing-cooling cycles on a permanent chart.

The electronic potentiometer employed in these systems is particularly adapted for use as a recording instrument situated in a central location. It is conceivable that the instrument could be mounted in the foreman's office where press functions could be analyzed at a glance. The air-operated control thermometers are less adaptable for control work at a distance, but they provide good accuracy when mounted at or near the press. The electronic recorder, with its small-gage thermocouple, naturally requires less installation space in the mold than would a thermometer.

The use of a throttling valve on the incoming steam line, to maintain die temperatures at or near a definite point automatically, is especially valuable in the molding of urea articles where overcure produces structurally weak products. However, in most cases, a throttling valve would not be absolutely necessary provided steam pressures can be safely kept at or near the point required for optimum molding temperatures.

Credits—Control systems designed by Brown Instrument Co.

Structural design

(*Continued from page 119*) decreased—precisely the phenomenon predicted by Fig. 2. It should be noted that the data given in Fig. 4 are based on actual fracture. This is satisfactory for the measurement of elastic stress-concentration since the material is perfectly elastic, or Type I. Figure 4 also shows that when the radius of the notch is 0.40 in.—the thickness of the bar under the notch—the breaking load is essentially the same as that for an unnotched bar 0.40 in. thick. This circumstance indicates that there is little if any stress-concentration existing at the condition of R/T = 1—an experimental verification of the previously stated engineering "rule of thumb" for the dimensioning of fillet radii.

Although the form in which the data are shown in Fig. 4 is satisfactory, it is more convenient to show the ratio of the breaking load with no notch to the breaking load with a notch, plotted as a function of the radius at the bottom of the notch. This is referred to as the "breaking load ratio." Figure 5 shows this type of curve for several rigid plastics. Since some of the materials for which such data are given are of the Type II variety, these curves do not represent true stress-concentration factors in all cases, but only serve as an indication of the fracture notch-sensitivity.

Fabric-filled phenolic materials, tested in the manner described herein, showed no tangible variation in breaking load as the radius of the notch was changed. The breaking load was the same for the unnotched bars as for those that were notched to varying degrees. These results indicate that materials of this type are not notch-sensitive—at least for the varieties tested. This also explains at least in part, why this type of rigid plastic has been frequently referred to as high-impact material, the Izod impact test on these materials not being influenced by "notch-sensitivity" as it is with Type I materials.

While only static stresses have been mentioned thus far, the concepts already discussed are applicable to impact or shock loading, as in the case of impact testing and accidental dropping. In the description of the fundamental types of rigid plastics, the room-temperature stress-strain properties were assumed. However, these concepts of stress-concentration and notch-sensitivity also hold for elevated and suppressed temperatures although the material may change from a Type I material to a Type II material at elevated temperatures and vice versa for suppressed temperatures. Should this be true, it would be logical to say that the notch-sensitivity of such a material would decrease with increasing temperature and increase with decreasing temperature relative to room-temperature conditions. Thus the degree of notch-sensitivity for any rigid plastic is a function of the temperature under which this property is evaluated. This is true of all the other mechanical properties, including tensile, flexural and impact strengths.

Summary—1) An appreciation of sound structural design is imperative to the plastics industry if success is to be gained in the field of structural plastics. 2) Stress-raisers, such as holes, notches, machined surfaces, abrupt changes in section thickness and re-entrant corners, should be eliminated from the design whenever possible. This is especially true in molded parts where mechanical failure, resulting from the design, means the inconvenience of major changes in the finished and hardened mold. 3) Materials which are not notch-sensitive should be used theoretically for all structural members in which the presence of stress-raisers is imperative to the functioning of the part. 4) Liberal fillet radii (fillet radius at least equal to the thickness of the thinnest section involved) should be furnished wherever members of rigid plastic materials are to be subjected to any appreciable operational stressing.

Guide for buyers

(*Continued from page 130*) order with the lowest bidder without due investigation. In the plastics industry, as in all industry, there are fly-by-night price cutters who will quote almost any price in order to keep the contract and then, when they have the customer thoroughly at their mercy with the necessary delivery date of the parts in the immediate offing or even after production has started, demand an increase in price before proceeding with or completing production. As often happens, the plastic part may be a small percentage of the value of the completed assembly. The customer, rather than risk non-delivery on his unit, will comply with the unjust demands of the molder and agree to the price increase.

There are many reasons for certain molders requiring a somewhat higher piece price. The fly-by-night concern does not furnish engineering or mold-making supervision. Ordinarily it does not carry insurance, and it practically never furnishes the services of a skilled artist and designer. The reliable molder who furnishes all these services has, by necessity, a higher overhead. However, to the majority of the purchasers of plastics, the slightly higher price necessitated by this greater overhead is one which he should be not only willing but happy to pay.

For example, take a company that manufactures and sells nail polish and its related products. The executives of this company decide that they wish to promote a new design for a box containing three or four bottles of nail polish, scissors, nail file, etc. It is decided that this box and contents should retail for $5.00. To make the package more attractive, some method of re-use must be decided upon. The problem is placed in the hands of one or more molders. These molders are requested to submit designs and sketches together with rough prices. Figure 1 shows a design which might have been

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submitted by any reputable molder. This box, designed by Jean Reinecke of Barnes & Reinecke, has a very definite re-use. After it has served its purpose as a container for the various manicure preparations, it can easily become a sewing basket (Fig. 2). With one or more drawings of this type in their possession, the beauty house will be in a position to decide sensibly just where to place their plastic molding work. As a matter of fact, they will also be able to contact some of their larger outlets and, with the help of this artist's rendering, gain a fair idea as to their approximate requirements.

Lights that talk

(*Continued from page 102*) small red bulb, or by wearing dark red goggles which completely shield the eyes. This procedure builds up maximum night vision so that fliers can actually distinguish many objects either inside or outside their ship in what amounts to total darkness. One ray of white light instantly destroys this build-up of night vision, just as one ray of white light destroys the photographic image on undeveloped film. Therefore, every precaution is taken to avoid exposing fliers to any white light. However, with this light, a white light is immediately available in case of an emergency or when a mission is completed and the plane is taxied around. It is only necessary to remove the front shield by squeezing two projecting pins which hold the filter in place. The filter is attached to the body of the lamp with a ball chain so that it cannot be misplaced.

All four of the parts (Fig. 2) that make up this light assembly are molded of medium impact cotton-filled material in 4-cavity transfer molds. The inner carriage, or tube, which slides forward for focusing, carries a threaded brass insert to accommodate the set screw which holds the part in position. The most difficult piece to mold is the one-piece L-shaped base and back of the fixture (Fig. 3). Self-tapping screws are used in place of inserts for electrical connections. The base which attaches the adjustable fixture to the wall of the plane is metal.

The lamp shown in Fig. 4 presented a tough problem which a new plastic may overcome. The unit is a bomb release signal to warn other planes in a squadron when not to dive under the ship on which the lamp is installed. The most important element is the lens which is made of a clear plastic material which withstands the intense heat generated by high candle-power bulbs located within $^1/_{16}$ in. of its surface. The oval lens is made in two parts—each a different color—and held together with special high- and low-temperature adhesive tape. Tests show that the lens can stand a heat of 350° F. over a period of hours without discoloration. Naturally, this places the material in the thermosetting group of clear plastics which are making such rapid progress in vital operations.

The color in this lens, embodied in the plastics rather than applied to its surface, is reasonably permanent. The lens is set in a rubber gasket and held in position by the metal lamp fixture which is fastened directly to the skin of the ship. This arrangement allows freedom for expansion and contraction of both the metal and plastic which vary in thermal behavior. The lens is not fastened directly to the metal frame but is held in place by pressure alone. A high-power reflector immediately back of the lens intensifies the heat to a degree that is enough to crack almost any type of glass or burn almost any known type of plastic material. While complete replacement of glass by plastic in this application had not been accomplished when this article was written, approval is expected soon because the plastics lens weighs only 33 percent as much as suitable glass and because less breakage occurs in installation.

In normal times the lamp company manufactures automotive and marine lighting equipment—fog lamps, spotlights, riding lights, marine markers for seadromes, airport markers, floods. They have been in this business for 15 years. Their experience with plastics during these hectic years of producing Army and Navy ordnance lighting requirements has been so encouraging that the company expects to expand the use of these materials after the war for purely economic reasons. They believe plastics make better electric lighting fixtures of many types, and at a lower cost.

Credits—Material: Indicator lamps, phenolic; Cockpit lamp, Resinox; Bomb release signal lens, Stock Plastics Co. Lights manufactured by Lights, Inc.

Case for synthetic fibers

(*Continued from page 97*) Pre-boarded seamless hose can be knitted on the circular knitting machines—an important economy in the hosiery trade. Nylon, the vinyls, acetate and many newer synthetics can be pre-boarded, and all will compete in the postwar market.

Because of its strength and elasticity, its high resistance to abrasion and low absorbency, nylon has many potentialities. It is entirely on allocation for military use, and such civilian items as are now available are made of reject nylon. Its war uses include tire cord for heavy trucks and planes, human parachutes for paratroopers, glider tow ropes, braid, etc. The great nylon cargo chutes for carrying tanks and heavy loads have already been mentioned. Another important military use of nylon is in the so-called alpine tents, made of nylon coated with a weatherproof and insect-proof finish. Nylon itself is mildew-proof and almost impervious to rot, since it absorbs little moisture. The tents are white on one side for use in snow and olive drab for use in the jungles. They are light, strong, not bulky.

Unexploited postwar markets for nylon are dresses and household fabrics that can be washed without ironing and that are crease-proof. A permanent set is given the yarn or fabric by treating it with steam or very hot water. Nylon slip covers, for instance, hold a crease without sagging and can be laundered without ironing. For shirting material, too, nylon is in demand. Nylon's high elasticity will give it preference in many markets and it has industrial uses, such as window screens and shoe fabrics. It can also be extruded in strips for the weaving of outdoor furniture. Indeed, nylon is in the happy position of choosing between consumer markets since its limited production is not sufficient to meet all demands. Its present price now ranges from $1.45 to $2.55 a pound, but the manufacturer points out that postwar prices of yarns for civilian uses may have no relation to its present price range. Its estimated postwar U. S. production of 22—23 million lb. compares with the following estimates: rayon production, 800 million lb. at the end of 1944; cotton production, 5600 million lb.; wool, 650 million pounds.

Vinyl resin fibers

Vinyl resin fibers are spun from a solution of vinyl chloride-acetate resin by standard acetate-rayon spinning equipment. These fibers have an all-chemical base, free from any vegetable or animal raw materials such as cellulose or protein. An elastic-type vinyl fiber produced by a modified process, has

exceptionally high elasticity and is used extensively in elastic goods. Both types are produced in continuous filament and in staple fiber form.

Unlike the other synthetic fibers, the vinyl resin fiber has the same tensile strength, wet or dry. It is water-repellent and nonflammable, although the elastic type fiber will support flame poorly. The yarn is wholly resistant to moths, mildew, and to acids and alkalis. It is highly thermoplastic, and its character of beginning to soften and shrink at temperatures above 150° F. has prevented its extensive use in consumer fabrics.

The vinyl resin fiber was in commercial use before the war in small quantities, appearing in such markets as shoe fabrics, but its remarkable resistance to acids made filter cloths its largest market. During the war vinyl resin fibers are on allocation, their chief military use being filter cloths. Other present uses are fabrics for screen printing and valve packing. The elastic-type of fiber is extensively used in paratroopers' athletic supporters, army hammock suspension cords and underwear for the women's services.

In the postwar era, vinyl resin fiber will probably compete with nylon in the hosiery market where its preboarding character, its elasticity and quick drying properties will be important, and it will probably enter the household textile field. Beautiful upholstery fabrics have been experimentally woven, ranging from stiff matelassés to sheers. Rich and supple satins have also been woven, and its thermoplastic quality lends itself to crease-proof fabrics. It will have a market in raincoats and waterproof goods, and in fireproof fabrics for public buildings. It has been experimentally used in the making of a pile fabric by fusion rather than by standard weaving.

Present prices of vinyl resin yarns are lower than nylon, ranging from $1.35 to $1.70, and it will probably have the advantage of a lower postwar price.

The vinyl monofilament is a new development which was not in use before the war, and has been used experimentally only. The distinction between yarns spun from a spinneret such as nylon, rayon or vinyl resin fibers, and a drawn monofilament, should be kept in mind. As the silkworm spins two fine strands or filaments and glues them together to make them stronger, so all the synthetic spun fibers come out of the spinnerets in fine filaments that are twisted together to make one yarn. Most monofilament fibers, on the other hand, being drawn out by a process similar to extrusion, are relatively coarse, since by the extrusion process they cannot be as finespun as by the spinneret process. These coarse fibers are used for the weaving of special-purpose fabrics such as screening and upholstery. For apparel, multifilament yarns are essential to give softness and suppleness; hence producers of many new monofilament fibers plan eventually to develop multifilament forms for their products.

Synthetic protein fibers

Synthetic protein fibers, like the natural protein fibers, wool and silk, have characteristic differences from the vegetable-based fibers—cotton or rayon. Casein fiber is produced from milk casein by a spinneret process similar to that of viscose rayon. Casein fiber is a wool replacement, and has been extensively produced in Europe under the names Lanital in Italy, casein fiber in Great Britain and Tiolan in Germany. Italy was the originator and the largest producer of casein fiber before the war.

Before it is spun into yarn, casein fiber feels and looks like wool. Its one important drawback is its lack of strength, casein fiber has a tensile strength approximately 70 percent that of wool when it is dry and considerably less than that when wet.

Casein fiber is blended usually with rayon in amounts varying from a minimum of 20 percent to a maximum of 50 percent. As the strength of the casein has improved, the proportion used in blends has been increased to its present proportions. Woven with rayon, casein fiber greatly improves the hand of the fabric, and adds warmth, resilience and wrinkle resistance. Its beautiful draping qualities are making it increasingly well known in the fashion world, although an important market is still the felt market where it is blended with rabbits' hair and wool for felt hats. Its felting qualities are good, and as its price is lower than that of wool, few felt hats are without some casein fiber. It is less frequently blended with wool than with rayon, since for wool, casein fiber is only an extender (adding no qualities which the wool itself does not have, and for an extending fiber most wool manufacturers prefer rayon staple because of its lower price. However, at its present price of 64 cents, casein fiber has found permanent markets in the apparel and felting trades. Government restrictions on the use of casein have restricted the production of casein fiber. Present production is not large—about 8 to 9 million lb. annually, roughly half that of nylon.

A new casein fiber has been developed, 15-micron fiber, said to be finer than any wool fiber and resembling vicuna or cashmere. It is typical of the fine weaves now being developed.

A soybean protein fiber now being produced is still in the experimental stage. It is made by extracting protein from the soybean, dissolving and treating it, and extruding it into fibers. It is a wool substitute, made up only in cut staple form for blending. In an article reviewing the soybean fiber in the May 1944 issue of *Rayon Textile Monthly*, Werner von Bergen states that its tensile strength is still poor, the soybean wool being 45 percent weaker than a corresponding grade of wool when dry and 76 percent weaker when wet. However, it is warm, resilient and durable enough for many blends, and textile men believe it has great potentialities. It is not yet in commercial production, and will probably not be sufficiently developed to be a factor in the immediate postwar world.

Also in the experimental stage is a cornmeal protein fiber produced from zein. Little is known about the fiber but the producers state that zein fibers have satisfactory resilience, elasticity and wet strength.

The peanut protein fiber is also a wool substitute, while an experimental fiber produced from the bark of California redwood has been used in blends for wool suitings. Production of textile fibers is fast becoming a chemical vogue, and new fibers from fish, seaweed, and animal sources have recently been announced. Their postwar possibilities are still nebulous. Other completely synthetic fibers such as the newly developed polyethylene monofilament expect to compete in the screening and rope markets. Styrene fibers, now used in important military applications because of their excellent military applications because of their excellent electrical properties, are well suited for low pressure bag molding.

Vinylidene chloride fiber

Although well established in special upholstery markets before the war, vinylidene chloride fiber has as yet no multifilament form, as have the other commercial fibers reviewed above. The new vinylidene chloride yarns are very much finer than the prewar yarns, however, and the producers expect to have yarns as fine and soft as silk and wool in the postwar era. (*Please turn to next page*)

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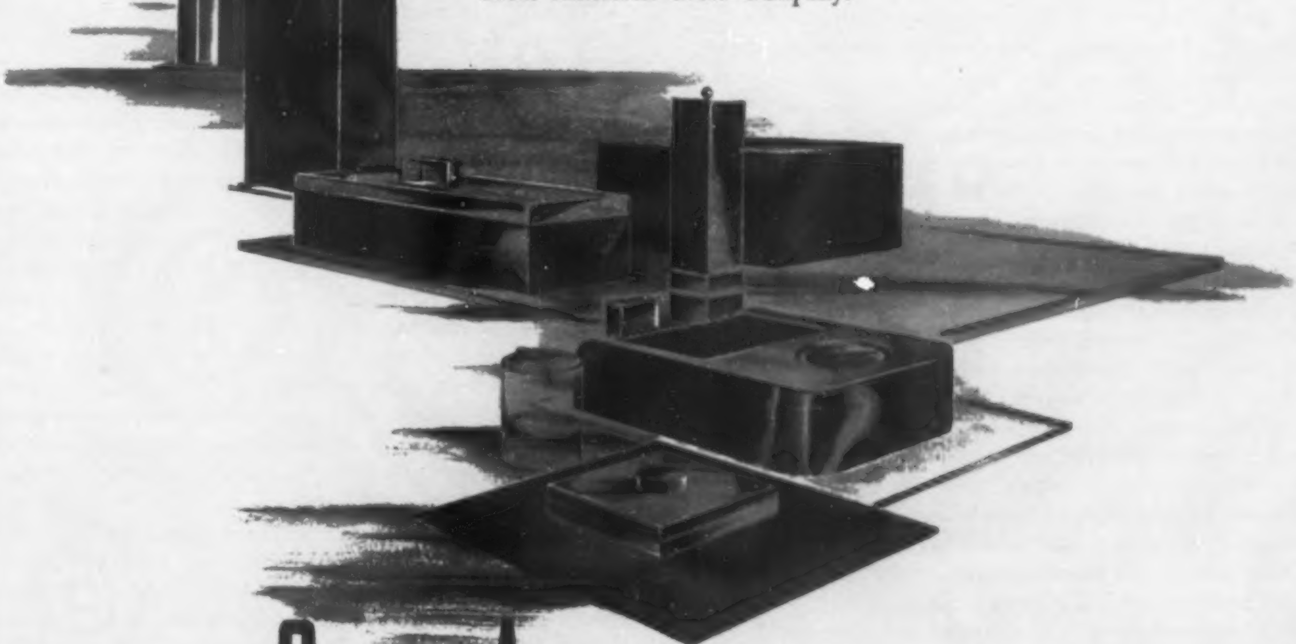

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Vinylidene chloride yarn is produced by an extrusion process. Its resistance to corrosion and flammability have marked it out for special war uses, such as insect screening. Because of its high tensile strength, abrasion resistance, and non-absorptive qualities, it had established a prewar market in upholstery for public buildings, luggage, shoe fabrics and waterproof goods. Introduced only in 1940, it was very much in demand for these markets, particularly upholstery. Railroads, buses, theaters, hospitals and public buildings used vinylidene chloride upholstery because of its sanitary qualities—the fact that it could be cleaned with soap and water and was impervious to dirt and even chewing gum.

During the war, vinylidene chloride yarns are on allocation, the bulk of the output going into screening which is widely used throughout the jungle areas of the South Pacific for protection against malaria mosquitoes and insects. Vinylidene chloride screening is said to be superior to bronze in corrosion resistance. It is tough, light, does not sag and can be rolled up without the casualties incidental to brittle metal screening. Another important war use is in inner soles for army boots, where its resistance to mildew, bacteria, insects and water adds to the comfort of our infantry. It is also used in collapsible stretchers and target cloth.

Without doubt, the largest postwar market for vinylidene chloride yarn will be upholstery, with secondary emphasis on luggage and shoe fabrics. It will also appear in belts and braiding and textile covering for electric wire.

While its chief postwar use will be for upholstery, it will also be used, as will many of the synthetics, in wallcloth. In airplanes, particularly, its light weight and flameproof qualities are as important as its easy maintenance. Vinylidene chloride fabrics recently developed for automobiles and airplanes are much lighter than prewar vinylidene chloride fabrics. Its weight gives it preference over the cotton wallcloth now used in airplanes, and in addition it has acoustical qualities lacking in cotton. In the language of textile men, the cotton balloon cloth now used cannot "breathe" because it is doped, and the sound, therefore, rebounds from it, whereas vinylidene chloride fabrics, being neither painted nor doped, absorb sound.

Vinylidene chloride yarns have many postwar possibilities in decorative fabrics, partly because of their easy cleaning possibilities, and partly because of improvements they facilitate in weaves and colors. The fiber cannot assimilate dye, but dye is incorporated into the resin solution before extrusion and is, therefore, permanent. It is sunfast and cannot be washed off. This quality makes possible the weaving of pastel upholstery fabrics, which hitherto were too delicate for cleaning. In special weaves, too, the vinylidene chloride yarn offers many possibilities, and its great tensile strength makes it invaluable in weaves like matelassé. Matelassé involves the making of a puff on the right side of the fabric which is held in place by a network of threads on the wrong side; in rayon and all natural fiber weaves, the matelassé puff wears off with time, but vinylidene chloride yarn holds a permanent, stiffer puff, and gives a better hand. Vinylidene chloride yarns before the war ranged from $1 to $3 a pound in price, but lower postwar prices are anticipated.

Vinylidene chloride is also extruded in coarse strips, which will have a postwar market in porch furniture and play rooms.

Vinyl polymer extrusions

Polyvinyl chloride-acetate is plasticized with a variety of plasticizers and extruded in elastomeric or semi-rigid form. While polyvinyl chloride-acetate's chief textile use is in coated and sheet fabrics and not in woven textiles, the tubing extrusions are woven into special fabrics and were used in drapery and trimming materials before the war. They are extruded in many bright colors, and will have a postwar future in the markets of decoration and trimmings, hats, handbags, etc. They will also be used for seat caning. Most of the present production is going into wire and cable insulation for war purposes.

Polyvinyl chloride

Like polyvinyl chloride-acetate, the more important uses of polyvinyl chloride do not enter into a paper on textiles, inasmuch as they are not woven, but are calendered into sheets or films or used as plastic coating for other fibers or fabrics. Polyvinyl chloride is, however, extruded as a monofilament. This is a new development since the war, and it has been woven only experimentally thus far. Its postwar use will probably include special purpose upholstery fabrics like the vinylidene chloride fabrics, and shoes, hats, and sports clothes that are rainproof, as well as screens and industrial uses.

Polyvinyl chloride is on allocation during the war, its entire output going into war uses, particularly insulated cable for planes and fabric coating.

Polyvinyl chloride is also extruded in tubing form, and its resistance to chemicals, to aging, and to water (it absorbs less water than rubber) have placed it in many markets. In the textile market, its most important quality is its elasticity, and a highly elastic plasticized polyvinyl has been used for men's suspenders, for garters and belts, and for shoes.

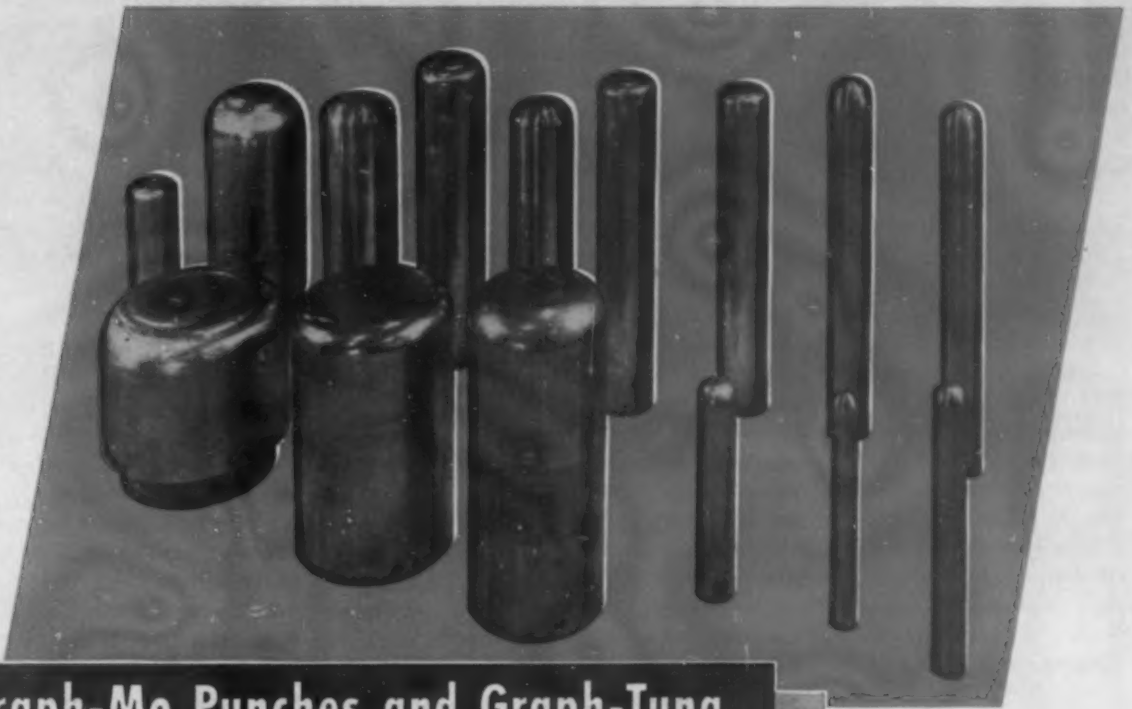
An important use of the extruded tubing after the war will undoubtedly be furniture, particularly outdoor furniture, for which it will be woven as chair covering, and in which its qualities of stretch and resistance to aging give it precedence over some of its older competitors in the fiber battle.

Glass fiber

Glass fiber, although a mineral rather than a synthetic fiber, is included in this discussion because it enters into the economic battle of the fibers. Glass yarns are produced in continuous filament and in staple fiber form, and are important for properties of insulation, fireproofing, resistance to acids and tensile strength. As a textile, however, glass fiber has certain limitations: its complete lack of absorbency prevents its use in the apparel and hosiery markets, and the fact that glass is, to some extent, soluble, makes the textiles subject to weathering. The finer the fiber, the greater its weathering propensities, and for this reason the glass yarns woven into fabrics are protected with a lubricant, an oil, or a synthetic resin coating. Glass fiber has excellent tensile strength, but very poor abrasion resistance, and slight rubbing breaks the yarns. The glass yarn is composed of many tiny glass rods (in the continuous filament process more than 100 filaments are gathered into a strand of yarn), each one as brittle as a glass cocktail rod.

The excellent insulating properties of glass fiber made glass cloth very much in demand for electrical applications, and before the war these were its chief industrial outlet. Military uses of glass yarns include fabric for shielding wires in divers' suits, fabric facing for insulation, insulating, sound-absorbing blankets for aircraft, blood plasma filters and parachute flare shades.

Postwar markets will include chemical filter fabrics and special cloths for acids, insulating, and rubber coated fabrics. Like the vinylidene chloride fabrics, glass fabrics will be used for wall cloth in airplanes and *(Please turn to next page)*



public buildings where their acoustical, insulating and fireproof qualities make them invaluable. It is doubtful if they will have a large use in the tablecloths, bedspreads, shower curtains and accessories for which they were occasionally shown before the war, although the very fine glass yarns now being experimentally woven will greatly enlarge the consumer uses of glass fibers. These yarns have a diameter of 0.00001 inches in diameter, and are so fine as to be invisible to the eye. They are very soft and pliable, and since one yarn is made up of hundreds of fibers, there is a relatively larger surface area which facilitates dyeing.

Glass fiber fabrics are now available for civilian use in limited quantities, and some beautiful fabrics in prints and colors have been woven for use in night clubs, theaters and public buildings. The dyeing of glass fabrics originally caused much difficulty as the glass yarns absorb no dye. By a German process the fibers were made hollow and dye introduced into the hollow rod, but in our country it is only recently that colored glass fabrics and printed fabrics are produced. Not all colors can be produced, but handsome richly colored fabrics are now woven. Some are woven with asbestos filling to improve the "hand" and body of the fabric. Rayon and cotton yarns are used, too, in combination, but these yarns cut down the *absolute* fireproof quality of glass fiber in the proportion in which they are used.

The present price range of yarns for decorative fabrics is 73 cents to $2.70 per lb. for continuous filament yarns, and 31 cents to $1.27 for staple fiber yarns. Glass textiles are more expensive than the yarn prices would indicate because the same poundage of glass yarn does not go as far in weaving as cotton or rayon.

On the whole, then, the synthetic fibers have already firmly established themselves in specialized markets in open competition with the natural fibers, and although most of the newer ones are in the frontier stage of a pioneer industry, faced with the technological and production problems incident to a pioneer industry, their future may be expected to follow the pattern of rayon. From a struggling industry bogged down with technological difficulties, with high price and small production, rayon has built itself into one of the major apparel fibers of the world. Not all of the synthetics, of course, will become major fibers, but all will have the advantage of increased production and lower prices in the postwar era because of the stimulus which both war and research have given to their production.

The outcome of the battle of the fibers is dependent on two factors—price and performance. On the score of performance, synthetics have given a good initial account of themselves and technological improvements are in progress. On the score of price, their future is uncertain. One important advantage which they may be expected to have in the price field is greater stability than the natural fibers. Even in the textile industry, retail trade is built on price stability, and the natural fiber industry presents a picture of retail stability at one end of the manufacturing scale, and at the other end of violently fluctuating raw fiber prices with a series of intermediate market levels which must adjust and cushion these differences as best they can.

Stability is only one element in the price structure, and it remains to be seen whether the synthetics can achieve an initial competitive price. Rayon staple at its present price of 25 cents a pound has a competitive price at which it is crowding cotton in the apparel market, since clean cotton fiber runs higher than the grade usually quoted and selling currently at about 21 cents. While the production of rayon staple is still relatively small (162 million lb. in 1943 as compared with 494 million lb. of rayon yarn and 5236 million lb. of cotton), its phenomena growth in production is significant. What the postwar price structure of the various fibers will be is a matter of guesswork, but it seems probable that *immediate* postwar prices will be close to what they now are. At these prices, rayon staple competes with cotton, as we have noted, and continuous filament viscose yarn at 55 cents (150 denier) and acetate at 56 cents (150 denier) both have civilian markets in apparel and broad goods which they carved out for themselves before the war in open competition with other fibers. Casein fiber at its present price of 64 cents is not a competitor of wool, although wool is considerably more expensive, selling currently at $1.20 (scoured). There is reason to suppose, too, that the large stocks of wool on hand in this country, built up by the Government to prevent a shortage, will cause some reduction in the postwar wool price. Casein fiber, however, has built up its own markets as a blending fiber in the felting and apparel trades. Nylon's prewar price was never stabilized, but at prices ranging from about $1.50 to $2.75, it ousted silk from many of its markets, and, unless great changes in price occur, will probably capture other silk markets after the war. Silk's price mounted steadily in the prewar years from a low of $1.13 in September 1934 to $3.08 in 1941, the last year for which it was quoted. Few of the other synthetics were available commercially before the war except in limited quantities, and therefore their prewar price is not representative of their possibilities. The present price of vinyl resin fibers, $1.35 to $1.70, should bring them into the apparel and upholstery trade, while vinylidene chloride even at its prewar price of $1 to $3 a pound had established itself commercially. At a lower price, it should be in demand.

Other factors influencing price and production of the fibers will be discussed in a later issue.

Acknowledgments

MODERN PLASTICS wishes to acknowledge the assistance of Joseph Leeming, American Viscose Corp.; the executives of A. M. Tenney Associates; H. R. Mauersberger, technical editor, *Rayon Textile Monthly;* Clarence Judd, industrial editor, *Business Week;* Harriet Raymond, Celanese Celluloid Corp., and of many individuals in the textile and plastics industry.

Synthetic yarns are sold under the following tradenames:

Viscose rayon:

American Enka Corp.: *Perglo, Briglo, Englo, Tempra* (high tenacity), *Vitala* (high tenacity). American Viscose Corp.: *Crown* (general name for all Viscose products), *Dulesco, Chakelle, Tenasco* (high tenacity), *Rayflex* (high tenacity), *Fibro* (staple fiber), *Avisco* (high-tenacity staple fiber). Delaware Rayon Corp.: *Delray.* E. I. du Pont de Nemours and Co., Inc., Rayon Division: *Du Pont Rayon, Cordura* (high tenacity). Hartford Rayon Corp.: *Hartford.* Industrial Rayon Corp.: *Spun-Lo, Premier, Dul-Tone, Spun-Black, Tyron* (high tenacity). National Rayon Co.: *National.* New Bedford Rayon Corp.: *Newbray, Newlow, Newdull.* North American Rayon Corp.: *North American, Xtra-Dul, Supernarco* (high tenacity), *High Narco* (high tenacity). Skenandoa Rayon Corp.: *Skenandoa.* Tubize Rayon Corp.: *Tubize, Chardonize, Hygram* (high tenacity). Woonsocket Rayon Co.

Cuprammonium rayon:

American Bemberg Corp.: *Bemberg, Matesa, Aristocrat, Star Breeze, Snowkrepe.* United States Rayon Co.

Acetate rayon:

American Viscose Corp.: *Seraceta, Seraceta Fibre* (staple fiber). Celanese Corp. of America: *Celanese, Fortisan* (saponified acetate), *Celairese* (staple fiber), *Lanese.* E. I. du Pont de Nemours and Co., Inc., Acetate Division: *Acele.* Tennessee Eastman Corp.: *Eastman Acetate Rayon, Koda, Teca* (staple fiber). Tubize Rayon Corp.: *acetate.*

Nylon:

E. I. du Pont de Nemours and Co., Inc., Nylon Division: *nylon* (generic name for a wide range of polyamides produced by the du Pont Company).

Vinyl resin fibers:

American Viscose Corp.: *Vinyon, Vinyon E.*

Synthetic protein fibers:

Casein fiber—Aralac, Inc.: *Aralac.*

(Please turn to next page)

Soy bean fiber—Drackett Chemical Co.
Corn meal fibers—Corn Products Refining Co.

Vinylidene chloride fibers:

Dow Chemical Co.: *Saran*. Firestone Industrial Products Co.: *Velon*. Acadia Syn Products Div., Western Felt Works. National Plastics Products Co. Visking Corp.: *Permalon*. Hodgman Rubber Co.

Vinyl polymer extrusions:

Polyvinyl-chloride a etate—Carbide and Carbon Chemicals Corp.: *Vinylite*.
Polyvinyl chloride—B. F. Goodrich Co.: *Koroseal*.

Glass fibers:

Owens-Corning Fiberglas Corp.: *Fiberglas*. Glasfloss Corp.

Polyethelene:

E. I. du Pont de Nemours: *polythene*

Styrene fibers:

Dow Chemical Co.: *Polyfiber*.

Metallizing

(Continued from page 127)

A fourth cylinder was metallized by this spray method. But this time silver was used instead of zinc. The plastic cylinder was first treated with an electrical de-gumming or bonding process which affects the surface of the plastic material. Nothing was added to the plastic surface—nothing was removed from it. The metal was sprayed on as described and deposited at a recorded temperature of 272° F. When completely metallized, the cylinder was machined and found to be exceptionally hard. The hardness of the metal caused a number of metal particles to be dragged across the edge of the profile causing a certain raggedness. Because of this difficulty, it was necessary to stop the machining before the required dimensions were reached. The cylinder was then put into a coarse grinder and ground down to within a few thousandths of the required diameter. The cylinder was finish ground after a very fine finishing wheel was put on the grinder. Finally the surface was buffed and polished.

Due to some irregularities in the line of demarcation, it was not thought advisable to use this plated cylinder in final assembly. Instead the part was used experimentally to determine the strength of the bond. In the first attempts to remove the silver, a pen knife was employed but quickly abandoned when it was found that the silver could not be removed from the plastic in this manner. A hammer and a chisel were then brought into play. Almost three hours of hard work were necessary before all the silver was stripped from the cylinder (about 140 sq. in.) and most of the silver removed in this manner had portions of plastic adhering to it. In other words, the bond between the silver and the plastic seemed perfect. No burned or charred spots were noted on any parts of the plastic—either upon the cylinder surface or the pattern profile.

After much careful, painstaking salvage work, this cylinder was again sprayed with silver. The process of machining, grinding, finish grinding and polishing was repeated, and a cylinder was turned out which proved to be entirely satisfactory for installation.

This cylinder was then tested for electric currents. The exploring point of contact was run on one position, i.e., held in one path on the revolving cylinder, for a period of 10 hours. After the tests were completed, it was found that no mark or scratch had appeared on the metal surface.

Description of process

The equipment used to metallize the plastic cylinders is a metal spray unit[1] with a chamber supplied with acetylene gas, oxygen at welding pressure, and air under a 60 to 80 lb. pressure. When the 1/8-in. silver wire which is fed through this chamber is ignited, a silver spray is forced out of a nozzle under high pressure (Fig. 1). Potentiometer readings indicate that the temperature of the melted silver as it leaves the nozzle is approximately 1300° F. lower than molten silver.

Prior to metallizing, the plastic surface of the cylinder is sandblasted (Fig. 4) and thoroughly cleaned. Henceforth the part is handled from the inside so that the surface to be metallized is not touched and dirtied. However, even with all surface dirt removed the plastic surface is still incapable of being bonded to the metal coating. There still exists a condition (not necessarily a substance) which reacts unfavorably. Consequently, before metal is applied, the electric treatment of de-gumming the plastic and preparing it for a metal bond is performed. The cylinder is put into a lathe so that it may be turned during the metallizing process. Lengthy experiments have shown that this process will remove an extraneous condition which might be vapor, film or upstanding microscopic fuzz that limits and even prevents bonding of the coating to the plastic. It takes approximately one-half hour to spray the silver onto the cylinder, the preparation for machining, the sandblasting and the arrangement for de-gumming and spraying takes approximately two hours. Care must be used throughout the spraying process to ensure that at no time is the metal surface touched by the worker. The least moisture from the breath or the hand will cause an imperfect bond. Temperature application was found to be about 272° F. which is considerably below the critical plastic temperature of 350° F.

Approximately 0.035 in. (60 oz.) of 0.998 pure silver was sprayed on the revolving cylinder. During this process the direction of rotation was reversed several times to insure close adherence to the line of demarcation between the plastic profile and silver. Immediately after spraying, the cylinder could be handled with bare hands. While it was too hot to be held comfortably in the hand, it was not hot enough to burn the skin. The part cooled very quickly and machining was started at once.

Oddly enough, throughout the months of experimentation and research which have been described above, no thought was given to the discovery of a proper method of bonding metal and plastic. The one aim was the completion of the experimental cylinders for the turret development then under way. However, disappointments and difficulties encountered in trying to perfect a method for bonding metal to plastic in this one application has brought to light a highly satisfactory process which can be successfully utilized for the war work of today and for the luxuries of tomorrow.

[1] Mogul Model "P" metallizing gun.

Synthetic resins in 1943

(Continued from page 116) approximately 100 percent increase over 1942. Practically the entire output of this type of resin was used in protective coatings. Three-fourths of the quantity produced was based on phthalic anhydride.

The production of polyvinyl butyral and related resins increased from about 6 million pounds in 1942 to over 14 million pounds in 1943. The figure of 6,737,000 pounds for polystyrene produced during 1943 is higher than previously published estimates. The allyl plastics are mentioned for the first time in this year's release. The production of allyl and furfuryl alcohol resins in 1943 is reported to have been 522,000 pounds.

Bonding metal to wood

(*Continued from page 103*) Laboratory tests have indicated little difference in shear strength with variations in the thickness of the coating, but it is essential that sufficient material be present to form a continuous film under the pressure and other physical conditions of the particular application. Best results are obtained if the application of the adhesive to both the primed metal and the wood surface is followed by room temperature drying for 15 to 30 min. or until a tacky condition is produced. Drying in this manner, before combining, allows escape of a large portion of the solvent.

Curing may be accomplished at room temperatures of approximately 75 to 80° F. Inasmuch as there is no necessity for heat being passed through the wood and metal during the curing operation, it is possible to stack many layers of metal-wood laminates together in one pressure unit—a circumstance that affords economy of press equipment. In addition pressure does not have to be maintained during the complete curing cycle. A total cure of 24 hr. is recommended before testing and, after a week, tests indicate further increase of bond strength.

TABLE II.—WET SHEAR STRENGTH OF CORDO-BOND

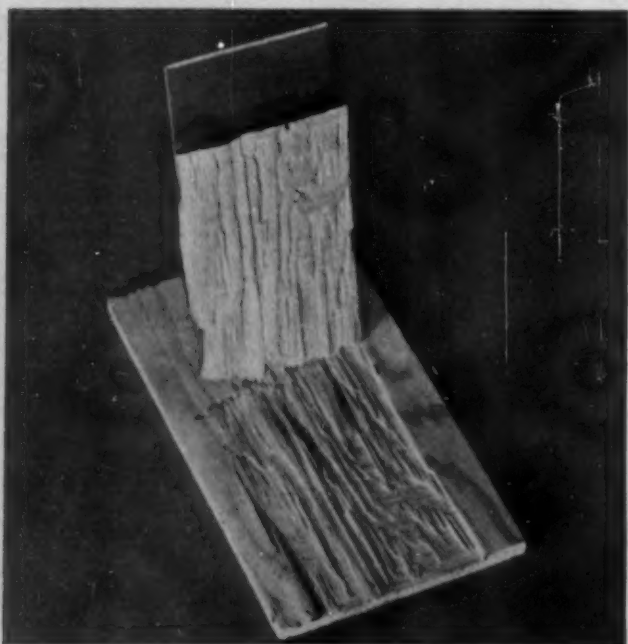
Metal	*Wood*	*Time of immersion in water*	*Shear strength*	*Wood failure*
		days	*p.s.i.*	*percent*
Aluminum	Birch plywood	0	700	100
Aluminum	Birch plywood	3	675	100
Aluminum	Birch plywood	5	700	100
Aluminum	Birch plywood	7	690	100
Aluminum	Birch plywood	21	300	100
Iron	Birch plywood	0	870	100
Iron	Birch plywood	3	800	100
Iron	Birch plywood	5	720	100
Iron	Birch plywood	7	740	50
Iron	Birch plywood	21	300	100

In many operations, especially where areas of overlap are small, the curing with heat is preferable because of the decrease in time required under pressure. At 130° F., a half hour under pressure and one hour total cure is satisfactory. At 200° F., the cure is complete within 10 min. after the glue line reaches that temperature. These relatively low-heat requirements permit the use of simple heating equipment. Higher-cure temperatures are not recommended.

Where facilities for baking at higher temperatures than those referred to above are available, the primer by itself has proved an excellent wood-to-metal adhesive. It may be applied to both members to form a continuous glue line when dried and pressed together. The total thickness of the two dried films should be 0.001 to 0.004 in.—depending upon the surfaces involved. The rougher the surface, the more the material is required to fill in between the metal and wood. The applied material should be dried completely, either by air-drying one to two hours at room temperature, or by force drying at elevated temperatures. After drying, the coated members are combined under pressure of 50 to 200 p.s.i. at

PHOTOS, COURTESY CORDO CHEMICAL CORP.

3



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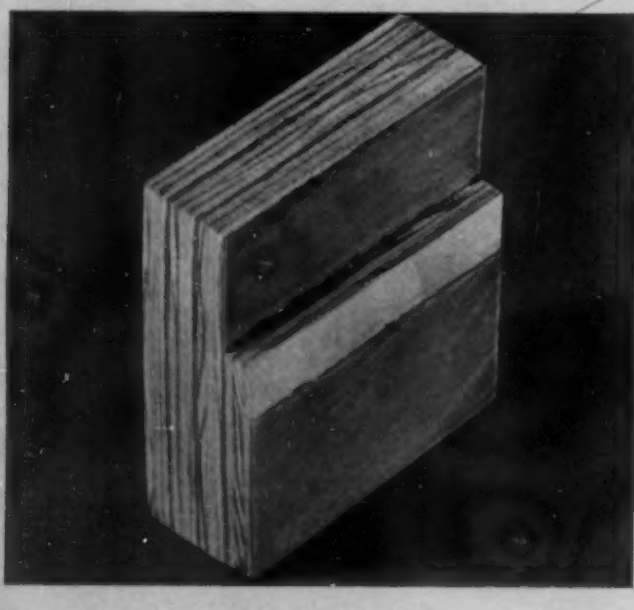

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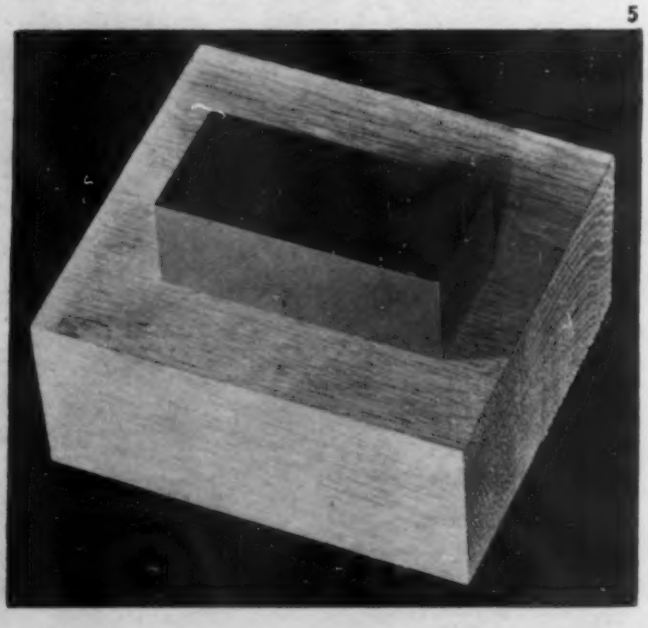

3—Aluminum bonded to resin-bonded fir plywood separates with 100 percent wood failure. 4—An example of the multiple and complicated laminates of metal and wood that are possible through the use of these adhesives. 5—This metal block bonded to oak illustrates the bonding of heavy sections. Shear strength is 1500 p.s.i.

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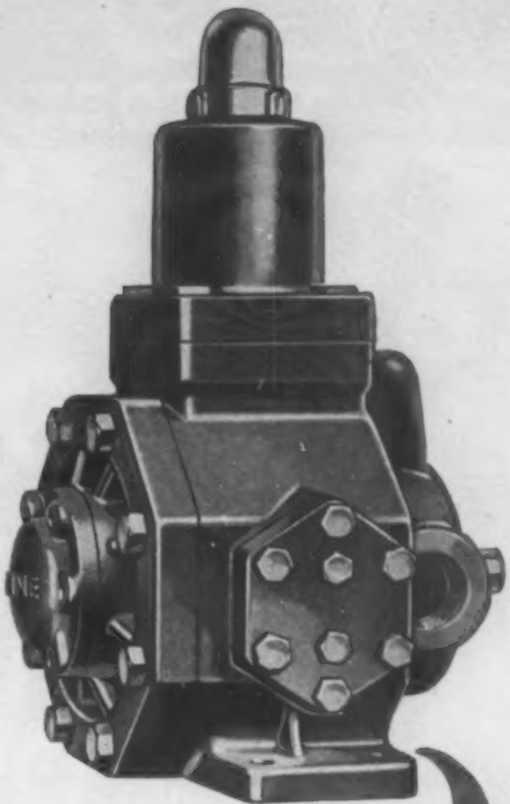

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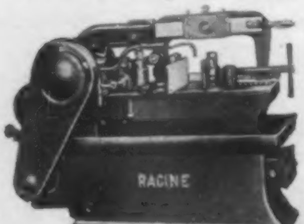

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TABLE III.—EFFECT OF TEMPERATURE ON SHEAR STRENGTH OF CORDO-BOND (ALUMINUM BONDED TO OAK)

Temperature	*Shear strength*	*Wood failure*
° *F.*	*p.s.i.*	*percent*
75	1400	100
125	1400	100
140	1200	75
150	1080	70
170	875	70
185	715	20

300° F. for 15 minutes. The laminate is water resistant. Shear tests of aluminum to solid maple give 2000 to 2500 p.s.i.

The uses of these adhesives in bonding metal to wood are without limit. Because bonding may be effected at low temperatures, large areas of plywood and stainless-steel laminates may be made. In addition to their current war applications, they will find wide use in the postwar era in the decorative field and for kitchen and restaurant structural work. Cabinets, tables, benches, sinks, etc., will present the appealing appearance and resistance of stainless steel, with the rigidity of plywood. Aluminum or stainless-steel store-fronts, service station buildings, etc., will be feasible. Production of laminated metal and wood by plywood manufacturers will permit custom fabrication of stainless-steel surfaced equipment by individual woodworkers.

The producers of the metal sheeting may coat the surface with the adhesive primer before delivery to the plywood-metal laminator. The actual bonding could then be done at any time. This would permit metal-wood laminates to be custom made, thereby opening the door to many new and varied uses.

For structural purposes, as in aircraft, automobile body and truck manufacture, these adhesives offer many interesting possibilities. Construction of structural steel trucks and buses may be simplified. Bonds of heavy pieces of metal to wood may be obtained without the use of screws and bolts. In this instance, the only limitation is the shear strength of the wood used and the amount of overlap that is allowable for the bonded area. Butt joints of metal to wood, previously obtainable only by screws and bolts or welding and with difficulty, can easily be made, thereby permitting new structural designs. Wood-metal sandwich construction for aircraft will permit the building of stronger light-weight ships.

Washington round-up

(Continued from page 166)

When M-331 was revoked and ureas were placed under M-300, small order exemptions for urea and melamine molding powders were raised from 100 to 2000 pounds. All other urea and melamine resin small order exemptions were raised from 1000 to 10,000 pounds. These changes are probably the first step toward total revocation of the urea order in the not-too-distant future.

The supply and demand situation for these materials has remained virtually unchanged in the last few months and there seems to be no reason for any alteration of the present picture. For several months, nearly all requests for urea and melamine for all purposes have been granted. The material has been allocated freely this year to all packaging uses, leather coatings, surgical pads, protective coatings, laminating resins, adhesives and textiles. A small quantity of molding powder was denied a few months ago for items of low essentiality. However, present allocations allow all these things on a deferred basis, and there is no evidence to indicate that there was not enough molding powder fill all requests.

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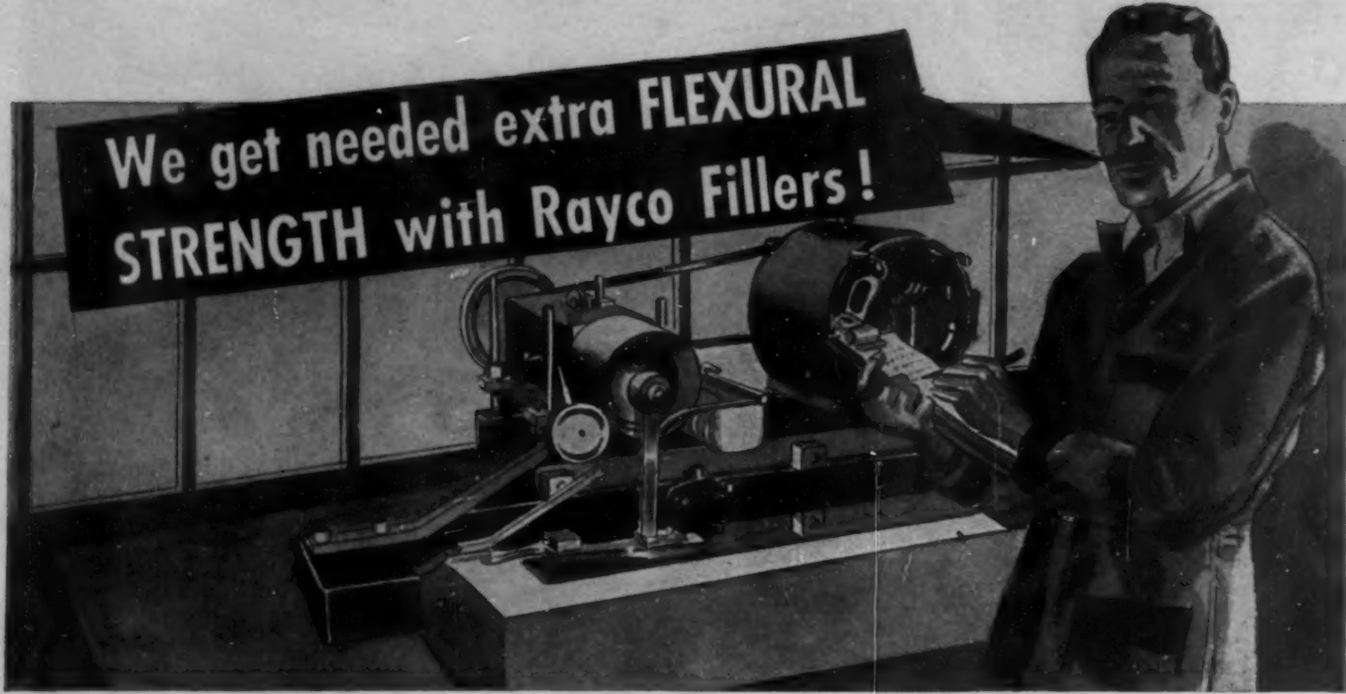
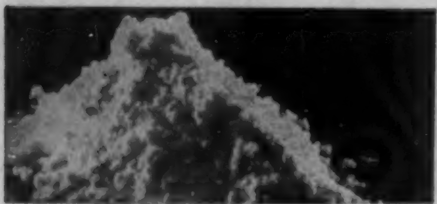
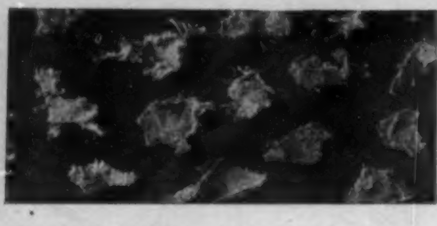


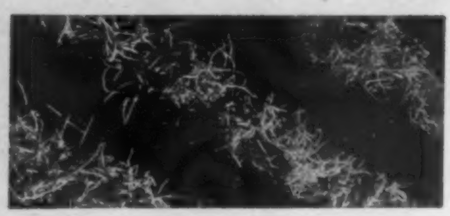
Rayco Fillers for EXTRA STRENGTH Plastics



FILFLOC Pure cotton flock of surpassing cleanliness and uniformity.



FABRIFIL Macerated cotton fabric for extra strength.



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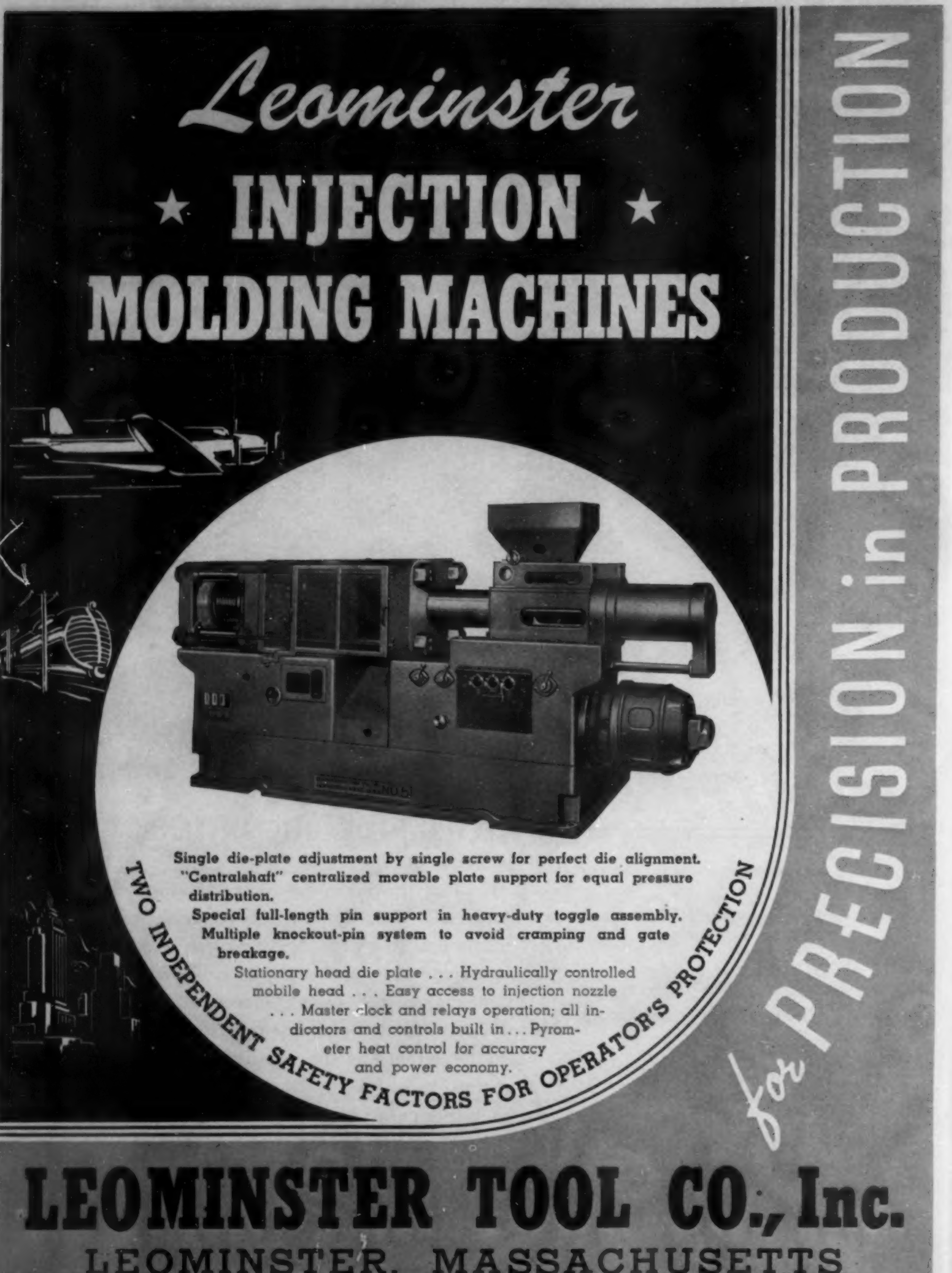
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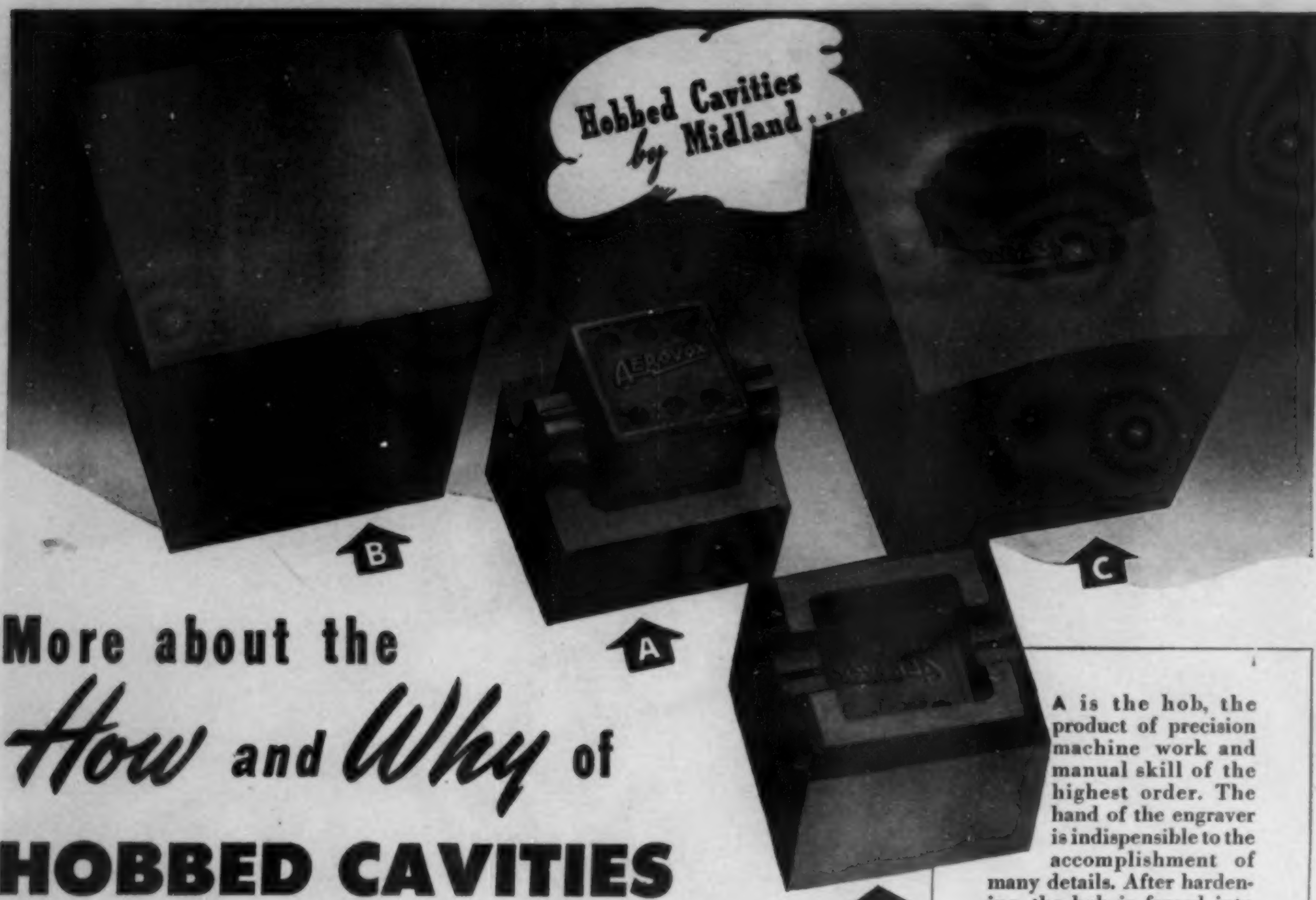

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When should hobbed cavities be used?
What are their advantages?

● Clear answers to these questions will help to increase the general understanding and appreciation of the process, and explain why it is a specialty at Midland Die & Engraving Company. On multiple-cavity jobs, hobbing saves weeks or months of time and labor, and is the logical method of assuring absolutely uniform cavities. For many shapes it is the only practical way to sink the cavity in a one-piece mold.

The example illustrated above is from a mold holding nearly a hundred cavities. One hob was made; on it the engraver and die maker exercised their special skills in full measure. Sinking this hob in a series of blanks was a simple and rapid operation done almost entirely by machinery, using many tons of pressure, though requiring skill in controlling the flow of metal in a cold state.

Some of the deepest and most intricate hobbed cavities ever made, were the product of Midland, where both equipment and experience in this field are exceptional. We invite inquiries from manufacturers, molders and die-makers, on any phase of mold or die construction.

A is the hob, the product of precision machine work and manual skill of the highest order. The hand of the engraver is indispensible to the accomplishment of many details. After hardening, the hob is forced into the blank, **B**, a block of prepared steel. For this operation, pressures up to 3000 tons are available. The sinking may require two or more pressings, with the block annealed before each.

The cavity, **C**, as it comes from the press, is a perfect facsimile of the hob, in reverse. Excess metal is milled away, and the piece is carburized, giving a surface comparable to the finest tool steel. Finishing the cavity requires precision grinding on all surfaces which meet other parts in the final assembly. Because of the high polish given the hob, the cavity itself requires a minimum of hand polishing to produce a mirror surface, assuring a perfect surface on the molded parts.

MD&E

MIDLAND DIE AND ENGRAVING COMPANY

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Makers of Plastic Molds • Die Cast Molds • Engraved Dies • Steel Stamps • Hobbings • Pantograph Engraving

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This wide-throat DoALL Zephyr is a new kind of band saw. It has been especially designed to handle quicker and smoother the new plastics, laminates, alloys and non-ferrous metals that are so necessary in war work today and will go into new products when peace comes.

A godsend to forward-looking manufacturers who want to use the new materials, but are stumped in cutting and shaping them because of unusual hardness, brittleness, etc.

The Zephyr does straight line, contour or bevel cutting. Accommodates large blocks and shapes, as well as parts of unusual length.

36" throat
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Variable speed from 1500 to 10,000 f.p.m.
4-way tilting table 30" square with 17 x 20" extension
Solid aluminum wheels, equipped with hydraulic brakes
Motor—10 H.P.
Occupies 48 x 60" space

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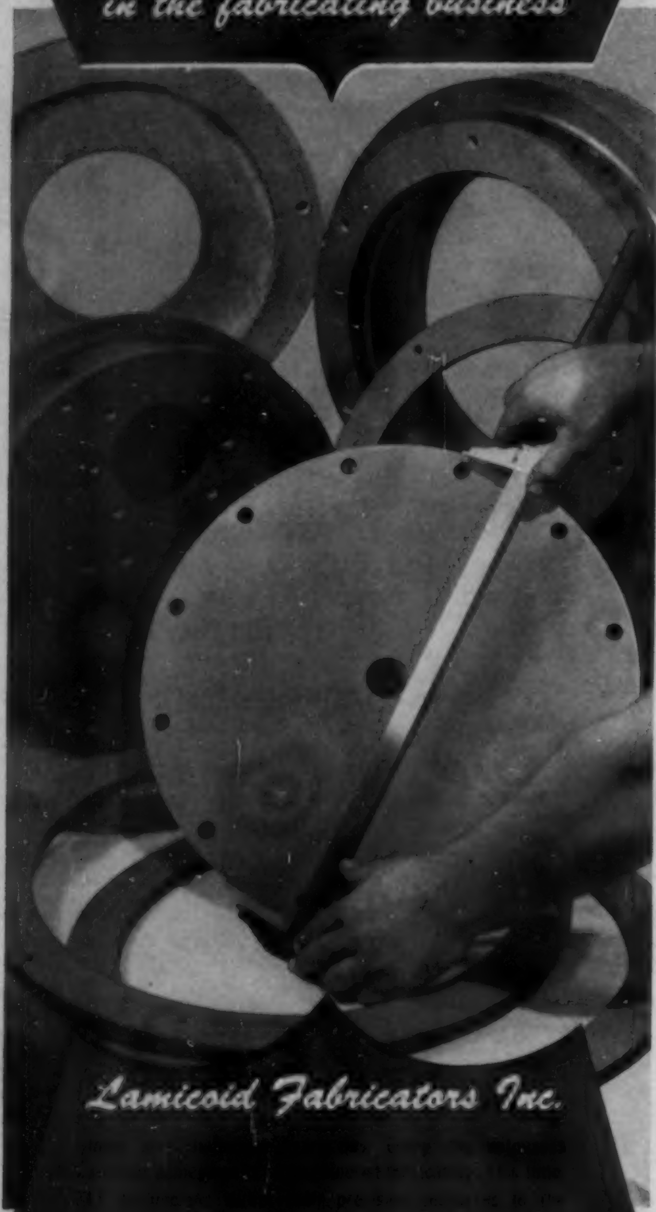

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Office and Factory Address in Dayton Remains Unchanged

Manufacturers in all industries in these areas who are interested in the use of injection molded plastic parts and products may now submit their prints and specifications *direct* to the new Standard Molding offices listed below. These new offices have been established to meet the increased demand for precision injection molded plastic parts in these areas . . . and to expedite service and delivery of Standard products.

Standard's injection molded plastics, already used extensively throughout the automotive-aircraft industries, maintain minutely accurate tolerances, are exceptionally long-wearing . . . durable. An economical application of injection molded plastics may improve your production —now, as well as after the war — and effect a worthwhile conservation of weight, labor and critical metals.

Standard Molding Corporation, a pioneer in the injection plastics field, invites you to use its specialized engineering knowledge and experience, its research and manufacturing facilities.

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THE SMC **Standard** MOLDING CORPORATION

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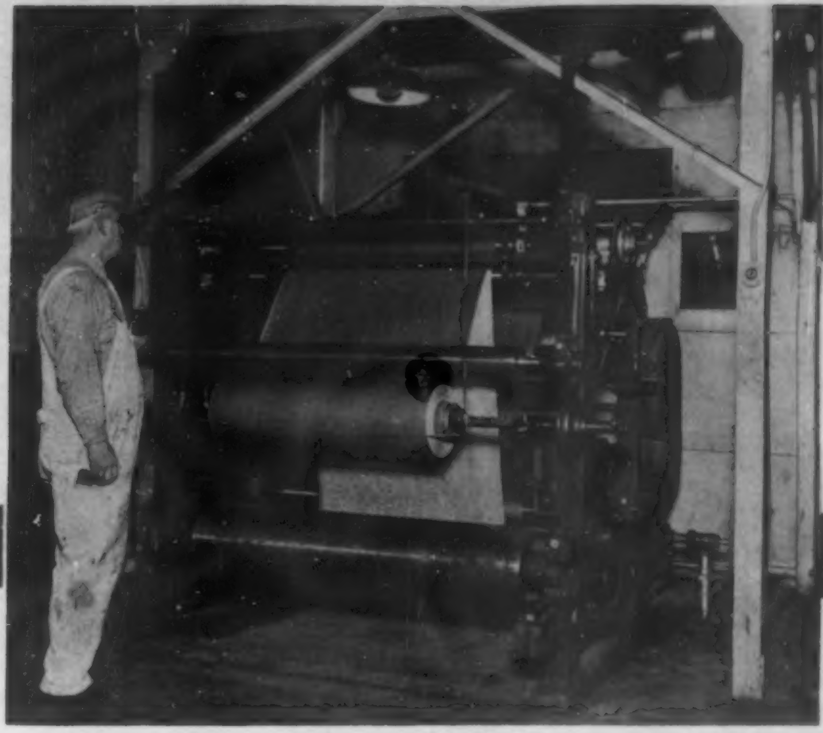
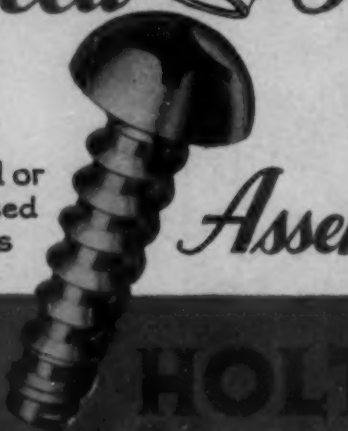


Photo shows coating machine applying insulating varnish made with a Varcum Resin. The finished product, coated cambric.

Speed King of Assembling



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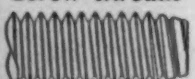
If you are looking for speed-up methods in your assembling, eliminate time-consuming tapping operations by using HOLTITE "Thread-Forming" screws for metal-to-metal and plastic fastenings. Cutting their own threads in drilled, pierced or formed holes, these speed screws effect a stronger, tighter, vibration-resisting fastening as each thread stays tight in the perfect mating thread it has cut in the material.

Furnished in three types—Type "A", "Z" and "C." Send for information of specific uses and methods. Check your assemblies—you'll find these speed screws can be used to save time and strengthen many parts of your products.

Also furnished with Machine Screw threads



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New Bedford, Mass., U.S.A.
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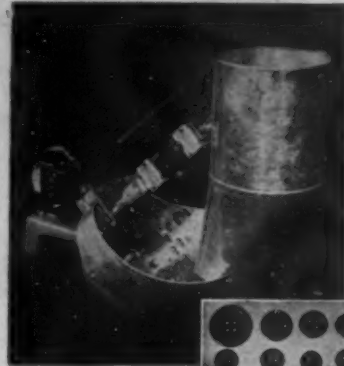
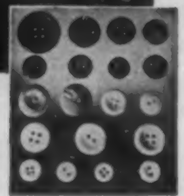
Automatic Button Finisher

ELIMINATES MANPOWER PROBLEMS





THIS compact automatic machine punches fins and cleans holes of Urea, Phenol and Melamine buttons. Completely automatic it saves countless man-hours of work and performs with perfect efficiency. Can be set & re-set to handle all sizes. 3 models: Model S accepts sizes 12 to 34; Model SP accepts sizes 36 to 50; Model SX accepts sizes 12 to 50. Production up to 450 per minute.

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In giant presses sheets of selected Douglas fir veneer, a bonding agent of heat-set plastic, and a surfacing film of a remarkable new fibrous plastic are permanently fused together. The result—INDERON.

Facts About INDERON for Postwar Planners

WHAT IS INDERON?

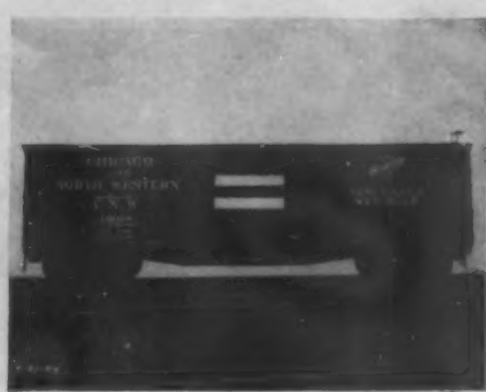
INDERON is a **new** stabilized structural product. Douglas fir veneers, plastic glues and a fibrous plastic film are chemically and infrangibly united under high heat and pressure to produce a complete, finished material in large panel form. INDERON is neither a plastic nor a plywood, but an alloy retaining the better qualities of both.

WHAT ARE THE PROPERTIES OF INDERON?

INDERON is waterproof, with a dense hard finish highly resistant to abrasion, impact, vapor permeation and water absorption. INDERON needs no surface protection, no decorative treatment, no structural support. INDERON is stable. It does not warp or twist. It combines BEAUTY . . . STRENGTH . . . DURABILITY.

IS INDERON CURRENTLY AVAILABLE?

INDERON, developed primarily as a packaging material for the Air Corps, was later adopted by all branches of the services for a wide range of specialized applications, particularly where resistance to tropical fungus, termites and weathering was important. While these vital war needs have taken practically all production, INDERON testing and research have continued—and after the war this unusual product will emerge as a new, distinctly **different** structural material.



The unusual physical properties of INDERON suggest many uses in coach and car construction. As a liner for the Chicago and Northwestern wet pulp car, shown above, all necessary requirements for this difficult type of service were met by INDERON. It is tough, hard, easy to install, low in cost.

INDERON is waterproof, effectively stops vapor transmission, creates an enduring surface, can be installed on both the interior and the exterior of freight cars. INDERON is considerably stronger than plywood, needs no paint or finish.

INDERON is successfully serving the Army Air Corps as the preferred material for packaging many vital parts, medical supplies and delicate instruments. INDERON has also been used for many other important war purposes, and has proven its ability to resist tropical fungus, termites, weathering and water immersion.

INDERON

THE *Stabilized* STRUCTURAL PRODUCT

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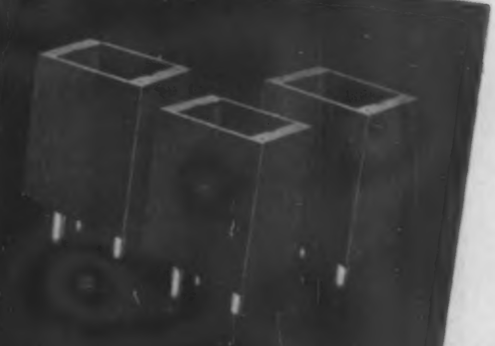
Curing time cut to 1/3 with *Airtronics* PREHEATER

HOWARD CRYSTAL HOLDER data

Dimensions: 1 19/32" long, 1 3/16" wide, 1 27/32" high.
Wall Thickness: Approximately 1/8"
Inserts: 4 knurled brass molded around top edge for attaching cover; 3 pins molded into base.
Weight: Preform—37.6 grams; total finished including inserts—40.5 grams.

Former Method	Operation	Preheating by AIRTRONICS
30 min.	HEATING PREFORMS	11 sec.
4½ min.	***CURING TIME***	**1½ min.**



"CURING TIME BY THE FORMER METHOD WAS 4½ MINUTES . . . BUT WITH THE AIRTRONICS PREHEATER THE CURING TIME IS ONLY 1½ MINUTES"

Howard Plastics, Inc.
Kansas City, Missouri

In the *same time* that they formerly cured *one* phenolic crystal holder case, Howard Plastics, Inc. are now curing *THREE*—which is a BIG saving in press time and labor costs. Based on the success of their first AIRTRONICS preheater they have re-ordered —to bring the same increases in output to other of their plastic molding presses.

Of particular interest to production molders, for whom the AIRTRONICS preheater was expressly developed, is the simplicity of controls, compact size and portability of the unit. Entirely self-contained, the AIRTRONICS high-frequency heat generator is ready to operate when plugged-in to a power supply. In the majority of plants where they are now installed, they are on a 24-hour per day schedule—quickly paying for themselves through increased production, reduced labor costs and lengthened die life.

Investigate the advantages of AIRTRONICS preheaters. Send for your copy of descriptive bulletin—find out how you can profit by the use of this advanced type preheater. The rated output of Model CB is 4000 B.T.U. per hour; area of the standard electrodes is 48 square inches; operates from 210-240 volt, A.C., 50 or 60 cycle current

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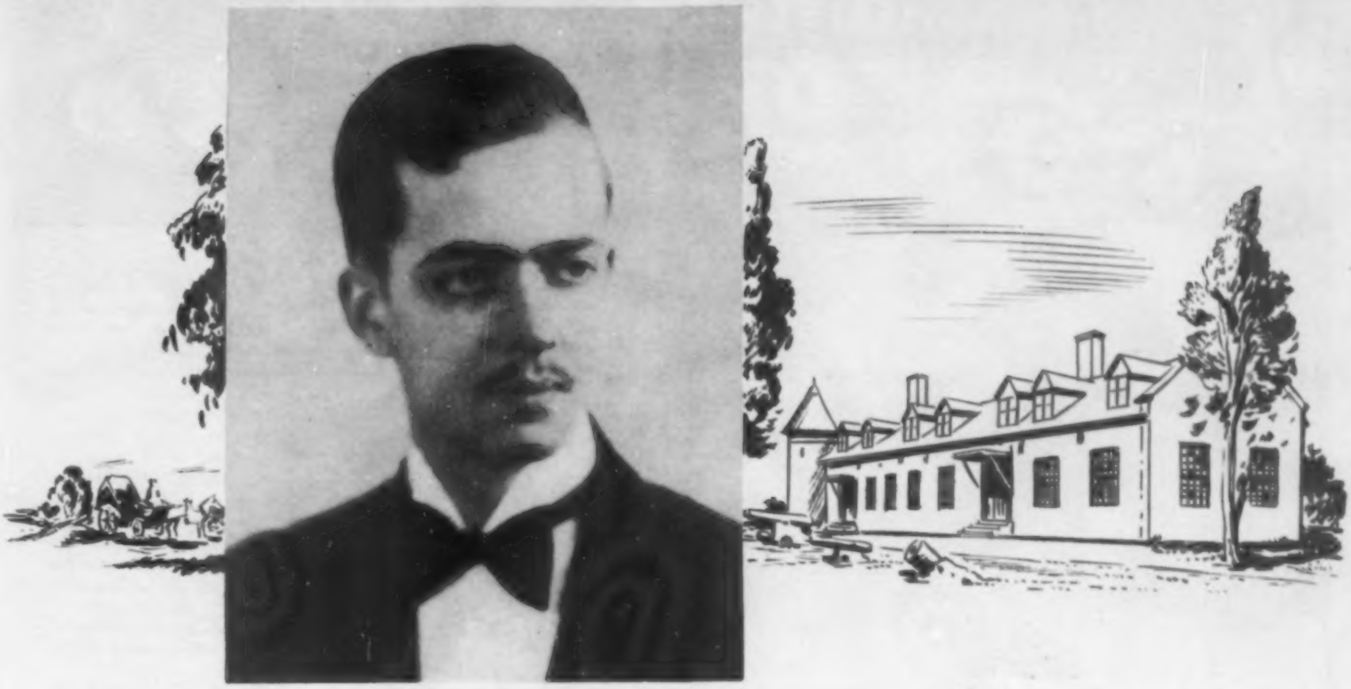

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Photo Courtesy of Sponge Rubber Products Co.

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The 3-M Adhesive Line has over 700 formulas and many of them are being used in all phases of industrial production; for adhering, sealing, coating, insulating, impregnating and sound-deadening. Many of these adhesives will meet your requirements, however should you find the present formulas not suitable, we welcome the opportunity to produce one that meets your needs. Please send us complete information on your problem—there is no obligation. For data on our more generally used adhesives—fill in and send us the coupon below.

Buy More War Bonds!

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We specialize in Compression and Transfer molding of Thermosetting plastics—Mechanical rubber products to specification—and Laminated materials.

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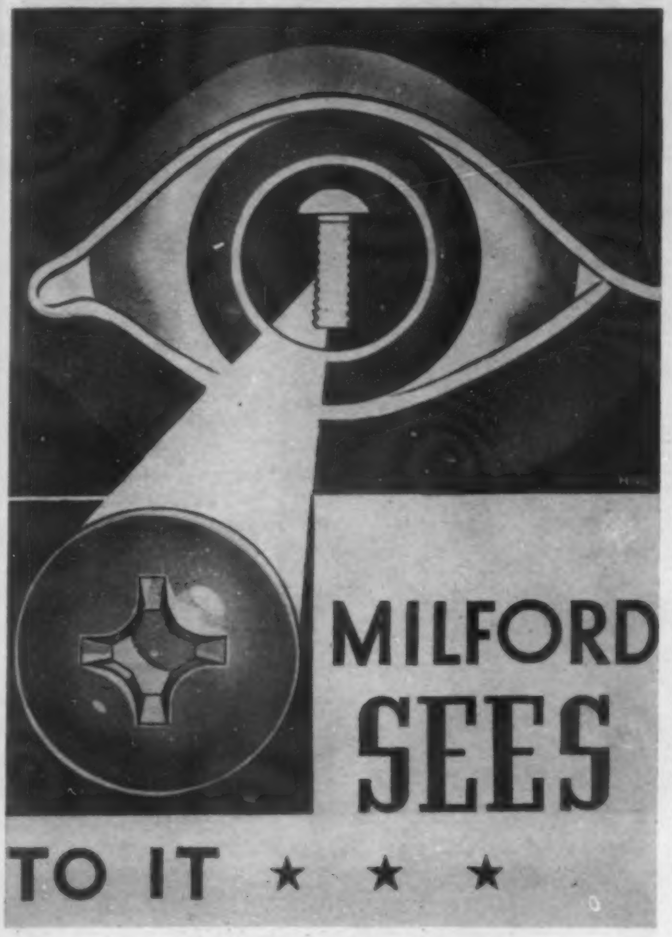
PHILLIPS *Recessed Head* SCREWS



that screws with the patented Phillips head are accurately machined and skillfully finished.

To speed your assembly processes uniformity in machine screws is highly important. If your source of supply is MILFORD you may depend upon it that particular care is given to this and other important details.

Production of machine screws, rivets and other fastening devices over the years has "in-built" the habit of precision in all MILFORD products.

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The MILFORD RIVET & MACHINE CO.

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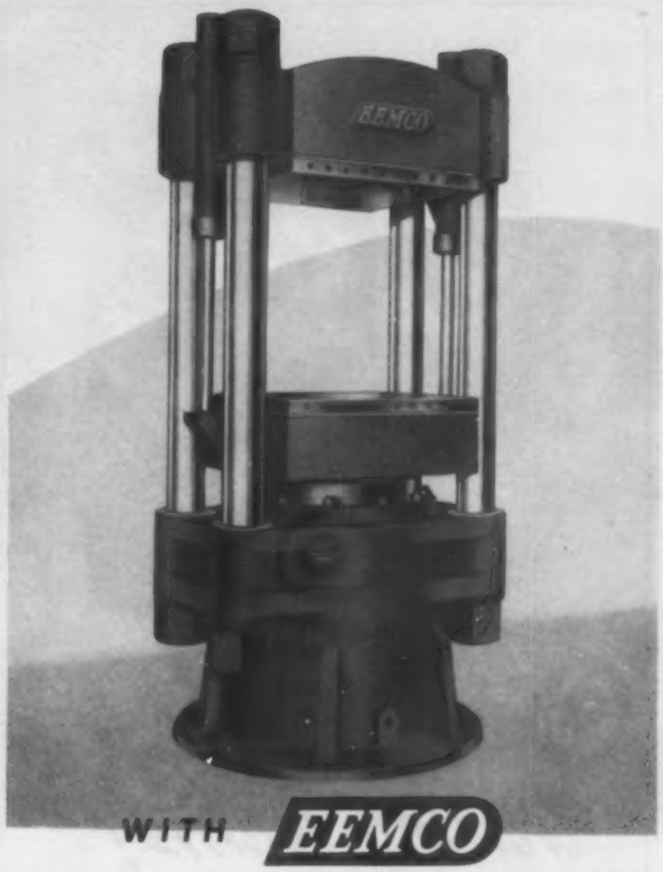
PLASTICS MOLDING



HYDRAULIC PRESSES

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WANTED: PLASTIC SCRAP OR REJECTS in any form. Cellulose Acetate, Butyrate, Polystyrene, Acrylic, Vinyl Resin, etc. Also wanted surplus lots of phenolic and urea molding materials. Custom grinding and magnetizing. Reply Box 318, Modern Plastics.

WANTED—SALES REPRESENTATIVES: To sell a new plastic board to molders, fabricators and all consuming industries. We operate our own paper mills. Do our own impregnating. Prefer an individual or organization with knowledge of the plastics industry and ability to find and develop potential users. Write, giving business references, names of accounts handled and territory covered. Reply Box 1025, Modern Plastics.

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FOR SALE: 1—500 ton Hydraulic Press with downward moving ram and pushbacks. Box 512, Modern Plastics.

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FOR SALE: Hydraulic Presses, 600 ton Watson Stillman 24" x 24", 4—36" x 36" 12" ram, 1—20" x 80" 4-8" rams, 1—52" x 26" 14" ram, 1—14" x 14" 8" ram, 6—12" x 12" 7½" rams, 1—20" x 20" 14" ram, 2—30" x 52" 1 with 15" ram 4 openings, 1—with 6" ram 3 openings, 1 Mystic Toggle 15" x 17", 1—14" x 20" Combination Hydraulic Toggle Pumps: 1—Watson Stillman duplex high and low pressure ¾ GPM 4000 lbs. continuous bedplate, Hele Shaw JLP 12 44 GPM 1200 lbs., HPM triplex 1¾ GPM 2000 lbs. on high 16 GPM 4000 lbs. on low V Belt drive, Robertson Triplex 5 GPM 5000 lbs. Union Steam Pump Viscolizer 3 GPM 3000 lbs. Gould Triplex 35 GPM 1500 lbs., 1—Logemann Triplex 12.8 GPM 3000 lbs. 2—Hauser 4 plunger 4.6 GPM 5000 lbs. on high 20 GPM 500 lbs. on low, Accumulator tank type 4" dia. ram 4' stroke, Watson Stillman hydro-pneumatic 9 GPS 6000 lbs. pressure, Vulcanizer horizontal 60" x 32" hinged bolted door, Extruders, Mixers, Mills, etc. Advise your Requirements. HIGHEST PRICES PAID FOR YOUR USED EQUIPMENT. Universal Hydraulic Machinery Company, 285 Hudson Street, New York 13, New York.

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Sales promotion executive, Plastics Institute graduate, highly successful, nation wide contacts with chain store organizations, long established New York Office, will promote new products or old on commission arrangement now, or when available. Shipping facilities and financing at your option. Please write to Box 1058, Modern Plastics.

IN THE MARKET FOR: Stainless Steel or Nickel Kettles, Vacuum Pan, Preform Machine and Mixer, Hydraulic Presses. Reply Box 825, Modern Plastics.

FOR SALE—1 Worthington Hyd. Pump 1 x 6, 5 GPM 6000 pressure M.D. 1 Hyd. Press 24" x 24", 14" ram; 1 Battery of 2—15 x 36 compounding rolls with drive at 75 HP motor; 1 W. S. 15" x 18" Hyd. Press, 10" ram; 1—14" x 24" Press, 9" ram; 4—24" x 55" steel cord Heating Platens; 4—W. & P. Mixers; 4—Semi-Automatic 100-ton Hydr. Presses, platen area 20" x 36"; Allen 6" Tuber; Dry Powder Mixers; Pulverizers, Grinders, etc. Send for complete list. Reply Box 447, Modern Plastics.

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FOR SALE: One Watson-Stillman 75-225 ton angle press, platen sizes 14 x 22 and 18 x 18; two Farrel-Birmingham compression presses 36 x 36, 13" ram. Reply Box 1060, Modern Plastics.

FOR SALE: Hydraulic Presses, Pumps, & Accumulators; W.S. 24" x 36", 6" ram; 22" x 24", 5½" Ram; 25" x 36", two 5" rams; 48" x 26", four 3½" Rams; 78" x 36", two 7½" rams; Farrel 30" x 23" Heated Platens, 8" ram; 400 Ton Hydraulic Extrusion Press; Royle 2 Extruder or Tuber; Hydraulic Pumps & Accumulators up to 5000 pound pressures; ½" & ¾" Preform Tablet Machines. Heavy Duty Double Arm Mixers up to 150 gals.; new Ball & Jewell Rotary Cutters; Grinders, Pulverizers, Gas Boilers, etc. Only partial listing. Send us your inquiries. We buy your surplus machinery. Stein Equipment Co., 426 Broome St., New York 13, N. Y.

WANTED: Copies of 1943 PLASTICS CATALOGUE. Creative Printmakers Group, 14 West 17th Street, N. Y. C. Chelsea 3-6803.

FOR SALE—IMPREGNATING EQUIPMENT—Combination dip tank and squeeze roll machine. Dip tank jacketed for heating or chilling of liquid. Rolls—6" dia. x 50" long, rubber covered. Speed reducer attached. All ball bearings. Fine condition. Price $750.00. Box 1063, Modern Plastics.

PLASTICS SUPERVISOR

We need a man in Los Angeles plant experienced in low-pressure laminates. Should be thoroughly familiar with shop practice and tooling; capable of supervising production. Good proposition for right man. Will pay moving expenses. Write Box 128, Station K, Los Angeles 11, Calif.

RESIN CHEMIST—A leading chemical manufacturer offers exceptional opportunity in laboratory development and technical service work for a chemist with extensive background of experience in production and use of synthetic resins. Must be capable of planning and supervising work. Knowledge of phenolic and alkyd resins essential. Excellent prospects for post-war period. Give full particulars, experience, education, salary expected, photo. Applicant employed will be required to have certificate of availability or referral card from U. S. Employment Service. This is an essential industry. Reply Box 1064, Modern Plastics.

TECHNICAL PLASTIC EXECUTIVE

Thoroughly versed with the art of coloring and economical compounding of plastics. Capable of directing research development, production and administration. Understands plant layout and proper equipment. 16 years industrial experience in plastics, synthetic rubber, protective coatings and adhesives. Seeks a responsible position with an aggressive firm. Address Box 1065, Modern Plastics.

EXECUTIVE SALESMAN—25 years experience selling to executives, now completing two years of practical experience in plastic manufacturing, will represent reliable firm. Widower, 53, free to travel anywhere. Excellent references as to character and sales ability. Box 1066, Modern Plastics.

FOR SALE: Elmes High & Lower Pressure Pump with motor Elmes Hand Pump. Oilgear Pump. French High Pressure Pump. Logemann Hand Pumps. Hydraulic Presses, all sizes. Air Compressors all capacities. Write or wire. C. S. Peck Co., 1681 W. Ogden Ave., Chicago 12, Illinois.

WANTED—AN ENGINEERING EXECUTIVE

A strong, well established, and progressive custom molder, located in the Middle West, requires the services of a seasoned engineer. Must know the molding of thermosetting and thermoplastic materials, as well as mold fabricating methods and costs. This position calls for a high calibre man, and pays accordingly. Please give full details in first letter. Address Box 1017, Modern Plastics.

WANTED
PRODUCT AND TOOL DESIGNER

By old and well established Eastern Molder. Man with good background who can vigorously swing into a postwar program. Give full details, age, salary, experience. Reply Box 1067, Modern Plastics.

WANTED
DETROIT REPRESENTATIVE

By molder with well established connections. A man with sound knowledge of plastic parts and tooling who has what it takes to produce business in a competitive territory. Our proposition is an excellent opportunity for the right man. State salary requirements, draft status, etc. Reply Box 1068, Modern Plastics.

PLASTICS CHEMIST: Desires research development or technical service position. Graduate Chemist. Age 30. Married. Draft 2B. Three years experience in molding, laminating and casting synthetic resins. Now employed as supervisor of group developing new resins for commercial applications. Postgraduate work in rubber and synthetic rubber technology. Prefers East or Midwest. Will consider postwar position in Mexico or South America. Reply Box 1069, Modern Plastics.

PLANT SUPERINTENDENT

BAKELITE FABRICATING PLANT has opening for above average man experienced in all phases of fabricating. Location Queens modern up-to-date plant. Reply Box 1070, Modern Plastics.

INDUSTRIAL DESIGNERS—A large manufacturer of automotive and commercial products wants several designers. Experience should cover rendering, modeling and engineering fundamentals. Excellent studio conditions. State salary and previous experience in letter to Electric Auto-Lite Company, Toledo 1, Ohio, attention Personnel Manager.

PLASTIC MOLD MAKER

Opportunity with old established firm. Experience with compression molds. Excellent starting salary. Apply in writing.

Mr. Robert M. Joffe
ALLMETAL SCREW PRODUCTS CO.
53 Crosby Street, N. Y.

DRAFTSMAN-ENGINEER—Duties to include designing of injection & compression molds for progressive manufacturing plant located in Massachusetts. Permanent postwar position. Excellent future. Give full details of experiences and salary desired to start. Reply Box 1071, Modern Plastics.

Plastic Sales Engineer desires position in Chicago or Midwest. Post war future. Experienced in production methods, product development. Groomed for Sales Engineering. Schooled past year in Plastics, Plastics mold design in New York. Three years experience with large Chicago firm. Can furnish excellent references. Age 25. Draft exempt. Now in New York. Will be in Chicago for interview September or October. Reply Box 1073, Modern Plastics.

Large general merchandising firm is desirous of entering the business of manufacturing plastics. It seeks a competent and experienced technician who can open and run technical end of such factory. We are prepared to make an attractive proposition to such man. Write giving sufficient information to warrant an interview. All replies treated in absolute confidence. Reply Box 1072, Modern Plastics.

WANTED—Chemist having thorough knowledge thermoplastics or with personally developed Vinylite formulae. Write fully. Box 1074, Modern Plastics.

Spence & Rigolo
PRODUCT DESIGN & ENGINEERING
MARKET RESEARCH
677 Fifth Ave., New York 22, N. Y.

TRENTON, New Jersey, Manufacturer wants experienced practical Plastics Engineer on part time or consulting basis to help solve injection molding problem. Reply Box 1076, Modern Plastics.

MECHANICAL ENGINEER with considerable experience in mold and equipment design, tool room practice, plastics plant layout, construction and maintenance, desires position as chief engineer. Reply Box 1077, Modern Plastics

WELL KNOWN toy manufacturer is interested in lining up for post war items in the toy field. Must be reliable and equipped for large volume production. Reply Box 1075, Modern Plastics.

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